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FINAL PERFORMANCE REPORT

FEDERAL AID GRANT NO. T-41-I

RESTORATION OF OPEN WOODLANDAND SAVANNA COMMUNITIES THROUGH SELECTIVE THINNING ON THE NATURE CONSERVANCY'S NICKEL PRESERVE

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

July 1, 2006 through December 31, 2009

Final Performance Report

State: Oklahoma **Grant Number: T-41-I**

Grant Program: State Wildlife Grant Program

Grant Title: Restoration of Open Woodland and Savanna Communities through Selective Thinning on The Nature Conservancy's Nickel Preserve

Grant Period: July 1, 2006 through December 31, 2009

Principal Investigators: Christopher Wilson, The Nature Conservancy`
Dr. Keith Martin, Rogers State University

A. ABSTRACT

In an effort to restore open woodlands and savanna habitat, The Nature Conservancy conducted selective thinning on 750 acres of the 17,000-acre Nickel Preserve in 2006. Crews used a combination of felling, girdling, and "hack and squirt" methods to kill trees and shrubs to reduce canopy cover, reduce stem densities, and alter tree composition to favor those species that would have been dominant under historical fire regimes. Monitoring was conducted pre- and post-thinning to determine the effects on vegetation structure (e.g. basal area and canopy closure), and the breeding bird and salamander communities. Thinning reduced canopy cover and basal area and increased abundances of ground/shrub and bole foraging breeding birds. A bat survey using mist netting and an ANABAT acoustic detector identified six species within and surrounding the thinned areas. Plant and animal diversity is expected to increase over time as thinned stands respond to open canopies, and as periodic fire consumes accumulated slash and leaf litter.

B. BACKGROUND

Early travelers in the Interior Highlands described a diverse landscape of prairies, grass-covered savannas, and very open woodlands with abundant herbaceous ground cover (Jansma and Jansma 1991, Schoolcraft 1819). Fire is believed to have been a frequent and widespread ecological process that maintained extensive open woodland and savanna communities throughout the Ozarks and the Ouachita Mountains (Foti and Glenn 1991, Ladd 1991). Prior to the middle of the twentieth century, the region had a history of frequent fire. In addition to lightning-set fires that most often burned in the spring and summer, Native American tribes were known to have set fires each autumn. Studies using fire scars have determined that low-intensity fires burned these systems quite frequently prior to the modern era, with average fire return intervals of 3 to 5 years for most sites (Guyette and McGinnes 1982, Guyette and Cutter 1991, Cutter and Guyette 1992, Guyette 1995, Kreiter 1995). Fire is now virtually absent from the region except where prescribed burning is used by public and private land managers.

Historical evidence suggests that Ozark landscapes have changed dramatically in the absence of periodic fire. A study of the Arkansas Ozarks using General Land Office Survey notes found that 60% of the region was open woodland, savanna, or prairie in the early 1800s (Foti 2004). Records indicate that presettlement Ozark woodlands averaged 38-76 trees/acre. Current densities in much of the region average 300-1,000 stems/acre (Anderson 2003). The Ozark landscape of today is more homogeneous and less diverse than in the past. The historic landscape, which was a mosaic of fire-maintained oak & pine woodlands and savannas, has largely been replaced by a continuous closed canopy forest containing a dense midstory and a depauperate ground-level herbaceous layer.

Numerous species of conservation need are dependent upon open woodland and savanna habitats (Table 1). Populations of several birds, amphibians, reptiles and invertebrates have declined over the past several decades with the loss of these open habitat types (The Nature Conservancy, Ozarks Ecoregional Assessment Team 2003). As significant tracts of woodland and forest continue to become denser in the absence of fire, these species require the immediate attention of land managers. While a general recognition of the importance of fire seems to be increasing in Oklahoma Ozarks, very few entities have specifically initiated programs to enhance habitat for species requiring open woodland and savanna habitats.

Table 1. Species of Greatest Conservation Need occurring in open woodland and savanna habitats (Oklahoma Comprehensive Wildlife Conservation Strategy).

Species	Status and Trend
Bachman's sparrow	Low, stable
American burying beetle	Medium, unknown
Blue-winged warbler	Low, unknown
Harris's sparrow	Medium, unknown
Hooded warbler	Low, unknown
Kentucky warbler	Medium, unknown
Painted bunting	Medium, unknown
Prairie warbler	Medium, unknown
Red-headed woodpecker	Medium, declining
Whip-poor-will	Medium, unknown
Diana fritillary	Low, unknown
Byssus skipper	Low, declining
Worm-eating warbler	Low, unknown
American woodcock	Low, unknown
Northern bobwhite	Medium, declining
Western diamondback rattlesnake	Unknown, unknown
Ozark big-eared bat	Low, unknown
Indiana myotis	Low, unknown
Gray myotis	Low, increasing

The Nature Conservancy is attempting to restore open woodland and savanna communities at its Nickel Preserve in the Oklahoma Ozarks. Prescribed burning has been used on more than half of the preserve during the past four years to maintain or restore these habitats, which are known to harbor a suite of species of conservation concern. However, fire alone has not been sufficient to

achieve the desired reduction in canopy cover and stem densities in forested areas. Midstory and overstory trees are simply too large to be affected by prescribed fire, at least in the short term.

It is becoming increasingly clear that the restoration of open woodland and savannas in fire-suppressed landscapes must first address the issue of dense canopies dominated by trees too large to succumb to fire in any reasonable time frame. Desired woodland and savanna vegetation structure can rarely be achieved through process-only restoration (e.g. prescribed fire) (Nielsen and others 2003). The dense forest structure resulting from decades of fire exclusion simply cannot be undone with one or a few fire events.

Nationwide, over 99% of the original savanna has been lost, and midwestern oak savannas are among the rarest ecosystems in the nation (Noss and others 1995). If these increasingly rare community types are to be restored, effective techniques must be developed and utilized at scales large enough to significantly benefit Species of Greatest Conservation Need.

C. OBJECTIVE

To restore the structural characteristics of fire-maintained woodland and savanna communities to 750 acres on The Nature Conservancy's Nickel Preserve, and to determine the effects of selective thinning techniques on bird and herp Species of Greatest Conservation Need.

D. APPROACH

The project was conducted at the J.T. Nickel Family Nature and Wildlife Preserve in Cherokee and Adair Counties. The area is located on the deeply dissected Springfield Plateau subsection of the Ozarks ecoregion. Elevation ranges from 184 m to 381 m above sea level. The surface geology is predominantly Mississippian limestone and chert (Branson and Johnson 1979). Soils on the area belong to the Sallisaw-Elsah- Staser Association (deep, gravelly, or loamy, nearly level to sloping soils on floodplains and benches) or the Clark-Baxter-Locust Association (deep, stony and cherty, very gently sloping to steeply sloping on timbered uplands (Everett 1970). Mean annual precipitation is 122 cm (Oklahoma Climatological Survey 2006). The vast majority of the preserve is dominated by oak-hickory forest, with shortleaf pine becoming dominant on south and west-facing slopes. Approximately 1,200 ac of the area is open grassland, much of which has been replanted to native tallgrass prairie.

Project personnel included several staff of The Nature Conservancy, university professors, and members of the forestry thinning crew.

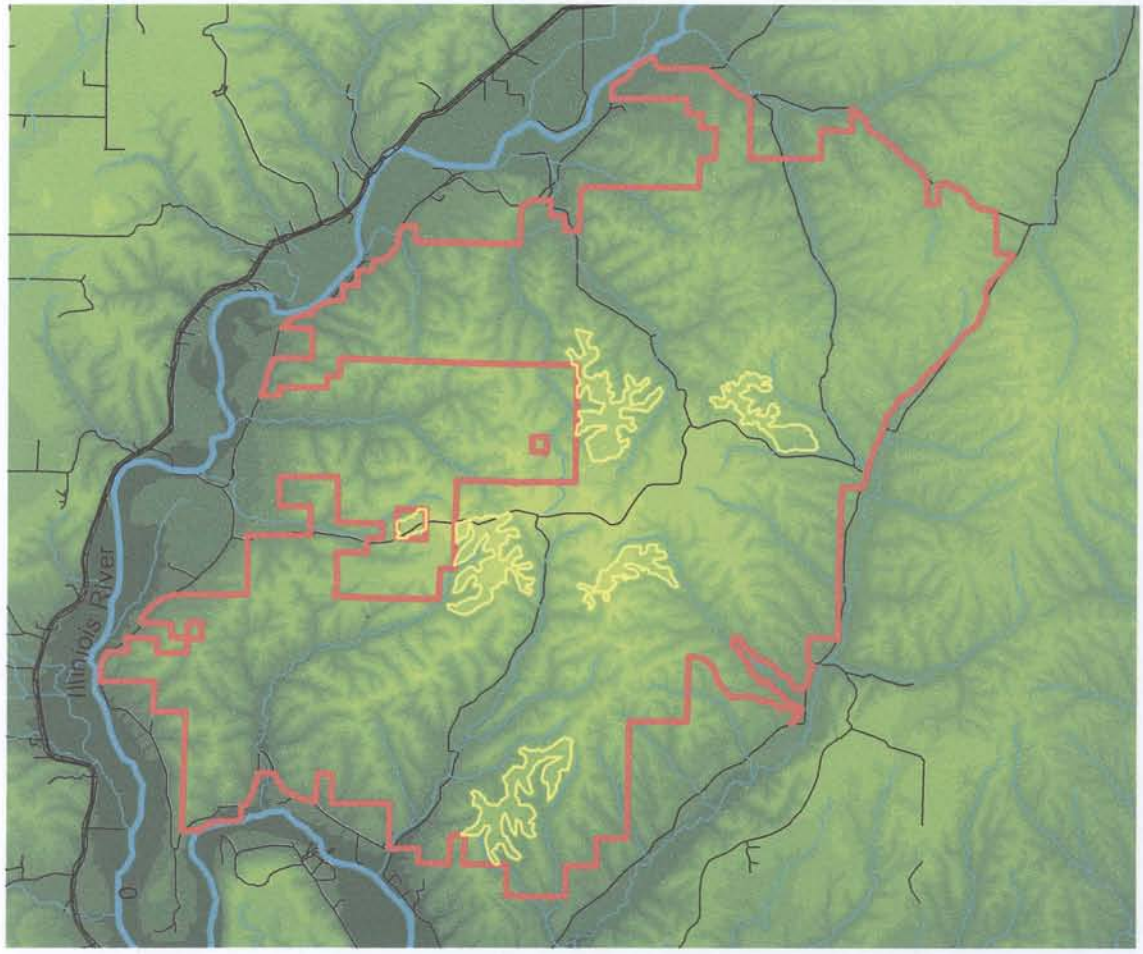
Personnel	Title	Agency or Entity
Christopher Wilson	Nickel Preserve Director	The Nature Conservancy
Christopher Walls	Stewardship Operations Mgr	The Nature Conservancy
Jeremy Tubbs	Wildlife Biologist	The Nature Conservancy
Larry Levesque	Biologist	The Nature Conservancy
Keith Martin	Professor of Biology	Rogers State University

Carlos Oseguera	Owner	Redleaf Forestry
Thinning Crew Members	Chainsaw technician	Redleaf Forestry

Thinning

Crews conducted thinning on six areas of the preserve during the late summer and fall of 2006 covering 750 acres (Figure 1). Thinning was done using a combination of chainsaws, machetes, and herbicide injection using Garlon 3. Depending upon existing stand structure, a combination of felling, girdling, and "hack and squirt" methods were used to kill trees and shrubs to meet the structural prescriptions. The structural goal was to reduce the basal area of woody plants to approximately 50 to 70 square feet per acre. Thinning was conducted with the primary objectives of reducing canopy cover, reducing stem densities, and altering tree composition to favor those species that would have been dominant under historical fire regimes (primarily post oak and shortleaf pine).

Figure 1. Thinning units (yellow) on the Nickel Preserve in 2006.



Monitoring

A subset consisting of three thinned units was selected to measure changes in vegetation structure and breeding birds (Figure 2). One unit was selected to measure changes in the salamander community. Pre-treatment baseline surveys for vegetation were conducted in 2005. Pre-treatment breeding bird surveys were conducted in June of 2005. Pre-treatment surveys of salamander populations were conducted between March and July of 2006. All of these pre-treatment surveys were conducted outside of the grant period and the costs for these were not charged against this grant. Post-treatment measures of vegetation structure were conducted in August 2007; post-treatment monitoring of breeding birds was conducted in June 2007, and post-treatment monitoring of salamanders was conducted during the spring of 2008 (Table 2).

Relative breeding bird abundance was quantified using fixed-radius point counts. Three 40-m radius circular plots with plot centers at least 200 m apart were established in three of the thinned units. Plots were censused in June of 2005 (pre-treatment) and 2007 (post-treatment). Each plot was surveyed for 10 minutes between 6 am and 11 am. All birds seen or heard within plots and within the larger treated stand were recorded by species.

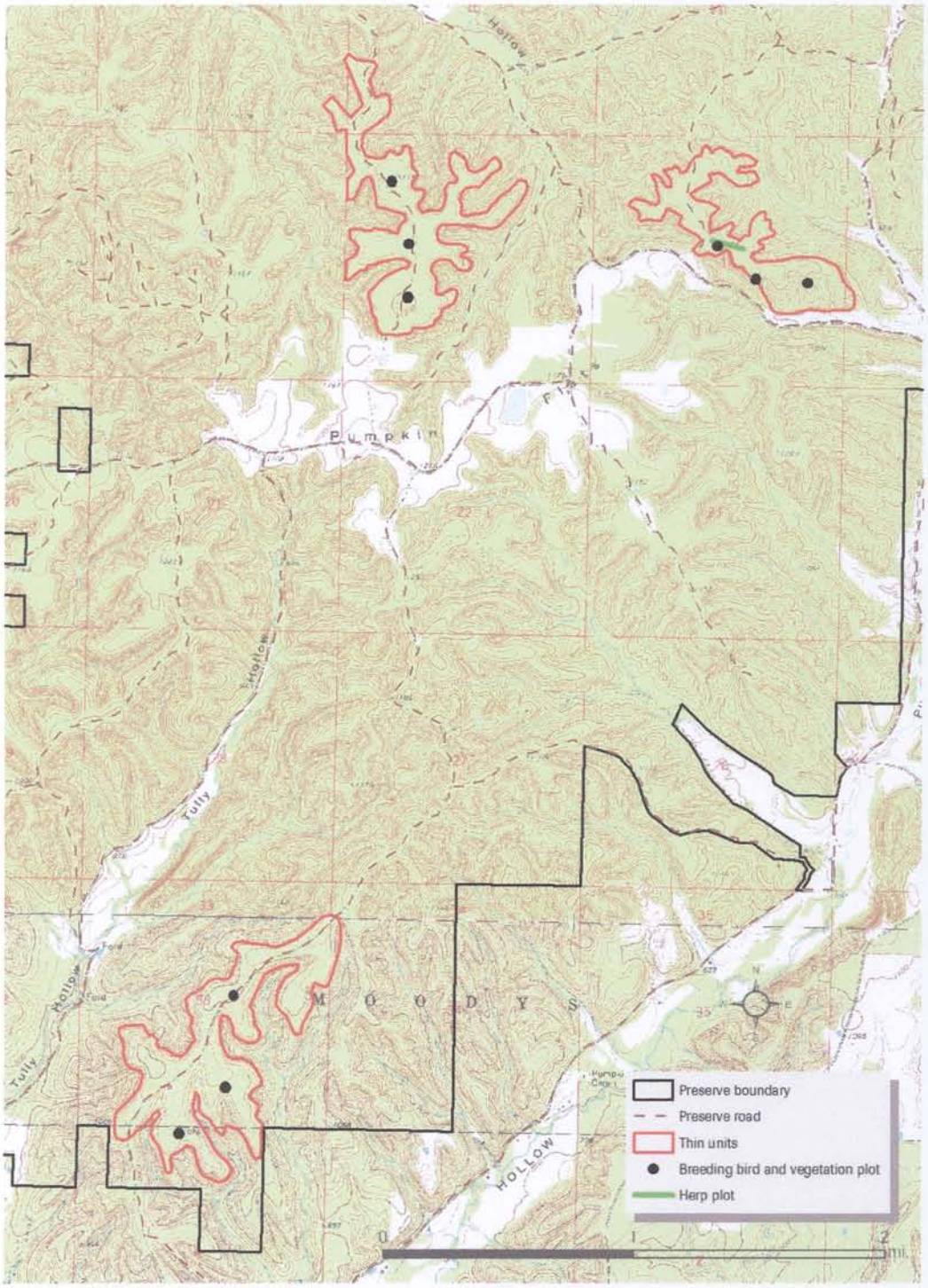
Vegetation measurement plots were established at the center of each breeding bird point count plot. From each plot's center, three 55-meter transects were placed at 0, 120, and 240 degrees. Basal area readings were taken using a 10-factor prism at plot center and at the endpoint of each transect. Canopy cover readings were taken using a densitometer every 5 meters along each transect for a total of 33 points per plot. Photo points were taken at the plot center and the endpoint of each transect.

Salamander occurrence was measured using paired cover boards spaced 10 meters apart along 90-m transects within the Triangle thinning unit. Transects were sampled from March-July in 2006 and 2008. Each board was lifted to expose any salamanders, which were recorded by species.

Table 2. Monitoring protocols for changes in vegetation structure, breeding birds, and salamanders.

Category	Indicator	Methods	Timing
Vegetation structure	Canopy cover, basal area, qualitative vegetation change	Sampling within treatment areas using a densitometer, 10-factor prism, and permanent photo points	August-September pre- and post-treatment
Breeding bird community	Relative abundance by species	Permanent point count plots within treatment areas	June pre- and post-treatment
Salamander community	Index of abundance by species	Transects of paired cover boards	March-July pre- and post-treatment

Figure 2. Breeding bird, vegetation, and herp sampling locations for the Nickel Preserve thinning project.



Bat Surveys

Bat surveys during spring and autumn involved capture and/or identification of species by:

- Strategic placement of mist nets over springs, ponds, and in canopy openings in three prominent valleys (hollows): Tully, Dog, and Sawmill hollows; and in two distinct upland habitats representing the higher elevations on the preserve: Pumpkin Flats, and the east ridge of Tully Hollow. Mist-netting for bats was conducted by Keith Martin at Rogers State University in Claremore, Oklahoma. Dr. Martin possesses a federal endangered species permit covering both the gray bat and Ozark big-eared bat and follows the live animal handling protocols approved by Rogers State University.
- Use of an ANABAT acoustic detector to augment mist net captures to determine species richness in specific habitats listed above.
- Visual inspection of two anthropogenic structures and one small cave on the Preserve for use by roosting bats.

Using the methods outlined above, 10 monitoring efforts were conducted on the Nickel Preserve between 20 September 2006 and 21 June 2007. Captured bats were caught using 38 mm mesh, nylon mist nets of 9m, 12m, and 18m lengths. In addition to mist netting at strategic physiographic locations, an ANABAT acoustic detector was used to augment the determination of species richness in each specific location. Each species of bat has a distinct echolocation call sequence with a unique frequency pattern that can be identified by this signature in much the same way that a bird can be identified by its unique call sequence. A database that contains many sequences of various species is contained in the ANABAT library. The use of the ANABAT acoustic detector for this project was the first time this device was used for this purpose in Oklahoma.

Mist nets and use of the ANABAT device were used on five occasions between 20 September and 7 November 2006, and on four additional nights between 23 May and 21 June 2007. A visual, daytime inspection for possible bat use was conducted at two dilapidated anthropogenic structures, one in Dog Hollow and the other at the southern boundary of the preserve property, and at a small cave (< 50 m passage) within the Preserve on 6 June 2007.

E. RESULTS AND DISCUSSION

Thinning

A total of 750 acres was thinned in six areas (Figure 3). Work was inspected to the satisfaction of the project manager after completion. While each area is different due to variable initial stand structure and composition, each was thinned to meet the goals outlined in the project statement.

Figure 3. Thinned stand using cutting, girdling, and hack-and-squirt techniques.

Vegetation Change

The effects of thinning on vegetation were determined using quantitative measures of canopy cover and basal area. Treatment effects were variable based on initial stand structure and contract crew composition. However, all three units showed substantial declines in basal area and canopy cover (Table 3). For all units combined, basal area (ft^2/ac) declined from 88.3 to 64.7, while canopy cover declined from 74.1% to 60.6%.

Photo points show the early stages of changes taking place immediately after thinning (Appendix A). Each page shows a pair of photos, the top photo shows the stand prior to treatment, and the bottom photo shows the stand one year after treatment. Thinning has clearly altered the structure to successfully meet the goals of the project. It is expected that these changes will be increasingly evident as more trees succumb to girdling and herbicide injection, standing dead trees fall, slash is consumed by prescribed fires, and herbaceous cover responds to the more open canopy.

Table 3. Changes in basal area and percent canopy cover in the Tully East, Triangle, and Pumpkin Flats thinned units at the Nickel Preserve.

Tully East

	Pre-Thinning (2005)	Post-Thinning (2007)
Basal Area	76.7	70.8
Canopy Cover	73.7%	58.6%

Triangle

	Pre-Thinning (2005)	Post-Thinning (2007)
Basal Area	97.5	69.2
Canopy Cover	72.7%	63.6

Pumpkin Flats

	Pre-Thinning (2005)	Post-Thinning (2007)
Basal Area	90.8	54.2
Canopy Cover	75.8%	59.6%

All Units

	Pre-Thinning (2005)	Post-Thinning (2007)
Basal Area	88.3	64.7
Canopy Cover	74.1%	60.6%

Breeding Bird Community Changes

Twenty-five species of breeding birds were encountered in the point counts. In the 2005 pre-thinning survey, 15 species occurred within plots or within broader treatment stands. In 2007 after the thinning, 24 species occurred within plots or stands. The total number of individuals encountered increased from 44 in 2005 to 58 in 2007 (Table 4).

The effects of thinning on forest structure included a more open canopy, more standing dead snags, more slash on the ground, and more woody and herbaceous growth in the understory. The breeding bird community is expected to change over time as these changes in vegetation become more pronounced. Point-count surveys showed a large increase in ground/shrub foragers following thinning. Of the ground/shrub foragers, just one individual was encountered before thinning. After thinning, 12 individuals of 8 different ground/shrub species occurred.

Bole foraging species appeared to benefit from the increase in dead snags. Individuals of bole-foraging species doubled from 3 to 6. Canopy foragers appeared to decline in number following thinning, perhaps the result of the decrease in canopy vegetation.

Table 4. Breeding bird occurrence by foraging group in 40-m radius plots and within treatment stands before and after thinning.

	Before Thinning		After Thinning	
	Within plot	Within Stand	Within plot	Within Stand
Ground/Shrub foragers				
Brown-headed cowbird	0	0	0	1
Carolina wren	0	0	0	1
Indigo bunting	0	0	2	0
Mourning dove	0	0	0	1
Northern bobwhite	0	0	0	3
Northern cardinal	0	0	2	0
Field sparrow	0	0	0	2
Wild turkey	0	1	0	0
Midstory foragers				
Black-and-white warbler	4	0	1	2
Blue jay	3	1	1	3
Carolina chickadee	0	1	3	0
Summer tanager	2	3	2	3
Tufted titmouse	5	0	1	2
Yellow-billed cuckoo	0	1	2	0
Bole foragers				
Pileated woodpecker	0	1	2	1
Red-bellied woodpecker	1	0	0	1
White-breasted nuthatch	1	0	0	2
Aerial foragers				
Eastern wood-pewee	0	0	1	0
Great crested flycatcher	0	1	0	1
Canopy foragers				
Blue-gray gnatcatcher	5	0	2	0
Pine warbler	0	1	2	2
Red-eyed vireo	3	4	1	1
Others				
American crow	0	6	0	7
Barred owl	0	0	2	0
Sharp-shinned hawk	0	0	0	1
TOTALS	24	20	24	34

Salamander Community Changes

Thinning resulted in less canopy cover that in turn allows more sunlight to reach the forest floor. This likely leads to more xeric microenvironments that may favor some salamander species while negatively affected others. The greater amount of downed woody debris also may have affected habitat suitability for salamanders by providing more cover.

Sampling with cover boards yielded only one species (Table 5). This technique may have been limiting in its ability to truly identify all salamanders present at the site. Results show that only the Ozark Zigzag Salamander (*Plethodon angusticlavius*) occurred in sampling plots. Based on the data, this species appeared to decline in numbers following the thinning. However, this site was burned during the time between pre- and post-thinning sampling, which also may have had an effect on habitat suitability. Furthermore, the greater downed woody debris following thinning may have created more options for cover, thus decreasing the number of encounters beneath cover boards.

Overall, sampling intensity for salamanders was not high enough to make any conclusions regarding changes in the salamander community following thinning. It is likely, however, that as habitat structure continues to change in the years after thinning the salamander community will undergo changes as well.

Table 5. Salamander occurrence beneath paired cover boards spaced 10 meters apart along 90-m transects within Triangle thinning unit at the Nickel Preserve.

Pre-Thinning Sampling Date	Species	Individuals
3/22/06	Ozark Zigzag Salamander	3
4/25/06	Ozark Zigzag Salamander	1
5/20/06		
6/08/06		
7/25/06		
Post-Thinning Sampling Date		
3/23/08		
4/17/08	Ozark Zigzag Salamander	1
5/28/08		
6/20/08		
7/29/08		

Bat Surveys

Thirty-nine (39) bats representing five different species were captured while mist-netting during the project (Table 6). During the fall of 2006, there was a 21:2 male to female ratio and a 6:10 ratio during spring 2007. The ANABAT acoustic detector recorded 253 "identifiable" calls from bats representing four different species. The only discrepancies between the two survey methods

were the detection of several big brown bats by the ANABAT system (this species was not captured in the mist nets), and the capture of a single gray bat and a northern long-eared bat using mist nets but these were not detected by the ANABAT. The visual inspection of the anthropogenic structures and small cave on property did not result in identification of any individuals.

Table 6. Monitoring results utilizing the ANABAT frequency recorder compared to mist net captures on the J.T. Nickel Family Preserve.

Species	No. of ANABAT Calls	Mist Net Captures
Eastern Pipistrelle	200	4
Eastern Red Bat	31	10
Big Brown Bat	14	0
Evening Bat	8	4
Northern long-eared Bat	0	1
Gray Bat	0	1

F. Significant Deviations:
None

G. Grant Costs: $ 136,048.00

H. Prepared By: Chris Wilson
The Nature Conservancy

I. Date: 2/10/09

J. Approved By:

Wildlife Division Administration
Oklahoma Department of Wildlife Conservation

John D. Stafford, Federal Aid Coordinator
Oklahoma Department of Wildlife Conservation

K. Literature Cited

Anderson, M. 2003. Collaborative partnerships and landscape-scale fire restoration on the Bayou Ranger District in the Interior Highlands of Arkansas, USA. 2nd International Wildland Fire Ecology and Fire Management Congress.

Branson, C.C. and K.S. Johnson. 1979. Generalized geologic map of Oklahoma. In K.S. Johnson, C.C. Branson, N.M. Curtis, W.E. Ham, W.E. Harrison, M.V. Marcher, and J.F. Roberts, eds. Geology and Earth Resources of Oklahoma. Oklahoma Geological Survey, Norman, Oklahoma.

Cutter, B. And R. Guyette. 1992. A fire history of an oak-hickory ridge on the Mark Twain National Forest. Report from Challenge Cost Share No. 09-05-121.

Everett, C. 1970. Soil survey of Cherokee and Delaware Counties. United States Department of Agriculture, Washington, D.C.

Foti, T.L. 2004. Upland hardwood forests and related communities of the Arkansas Ozarks in the early 19th century. In Spetich, M.A., ed. 2004. Upland oak ecology symposium: history, current conditions, and sustainability. Gen. Tech. Rep. SRS-73. Asheville, NC: USDA Forest Service, Southern Research Station. 311 pp.

Foti, T.L. and S.M. Glenn. 1991. The Ouachita Mountain landscape at the time of settlement. Pages 49-65 in D. Henderson and L.D. Hedrick, eds. Restoration of old growth forests in the Interior Highlands of Arkansas and Oklahoma: proceedings of the conference. Morrilton, Ark.

Guyette, R. 1995. A history of wildland fire in the Current River Watershed. 74pp. Report prepared for Ozark National Scenic Riverways and MDC.

Guyette, R. And E.A. McGinnes, Jr. 1982. Fire history of an Ozark glade in Missouri. Transactions, Missouri Academy of Science 16:85-93.

Guyette, R. And B. Cutter. 1991. Tree-ring analysis of fire history of a post oak savanna in the Missouri Ozarks. Natural Areas Journal 11(2):93-99.

Jansma, J. and H.H. Jansma. 1991. George Engelmann in Arkansas Territory. Ark. Hist. Q. L:225-248.

Kreiter, S. 1995. Dynamics and spatial pattern of a virgin old-growth hardwood-pine forest in the Ouachita Mountains, Oklahoma from 1896-1994. M.S. Thesis. Oklahoma State University, Stillwater, OK.

Ladd, D. 1991. Reexamination of the role of fire in Missouri Oak Woodlands. Proceedings of the oak woods management workshop, Eastern Illinois Univ., Charleston, IL. Pp. 76-80

Nielsen, S., C. Kirschbaum, and A. Haney. 2003. Restoration of midwest oak barrens: structural manipulation or process only? Conservation Ecology 7(2): 10. (online) http://www.consecol.org/vol7/iss2/art10/.

Noss, R.F., E.T. LaRoe III, and J.M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. Biological Report 28. U. S. Dept. of Interior, National Biological Service, Washington, DC.

Oklahoma Climatological Survey. 2006. Oklahoma Climatological Data. (www.ocs.ou.edu). University of Oklahoma, Norman.

Schoolcraft, H.R. 1819. Journal of a tour into the interior or Missouri and Arkansaw...performed in the year 1818 and 1819. London.

The Nature Conservancy, Ozarks Ecoregional Assessment Team. 2003. Ozarks ecoregional conservation assessment. Minneapolis, MN: The Nature Conservancy Midwestern Resource Office. 48 pp.

Appendix A. Selected photo documentation pre- and post-thinning taken in 2005 and 2007. Top photos show pre-treatment; Bottom – photos show post-treatment