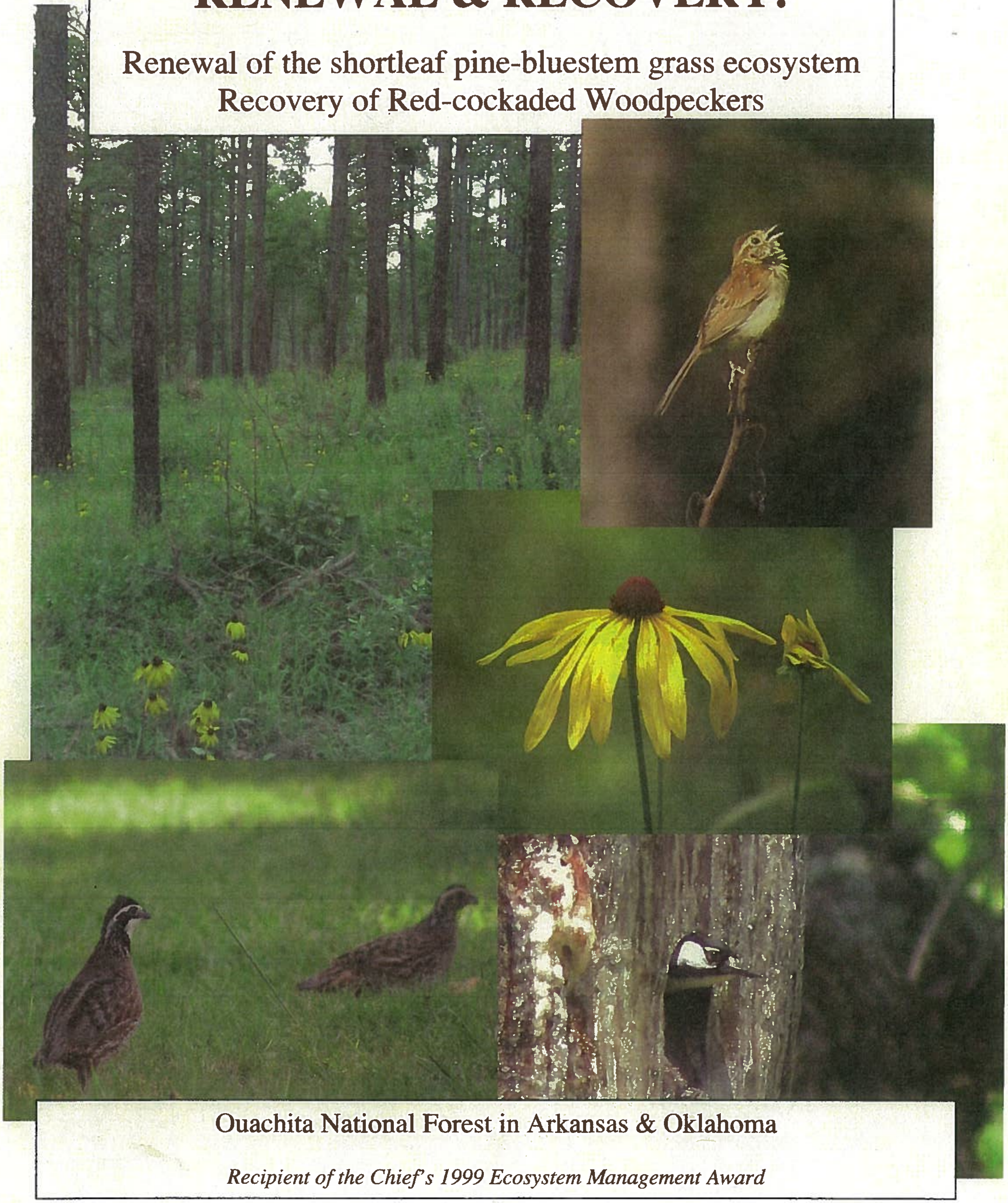
RENEWAL & RECOVERY:

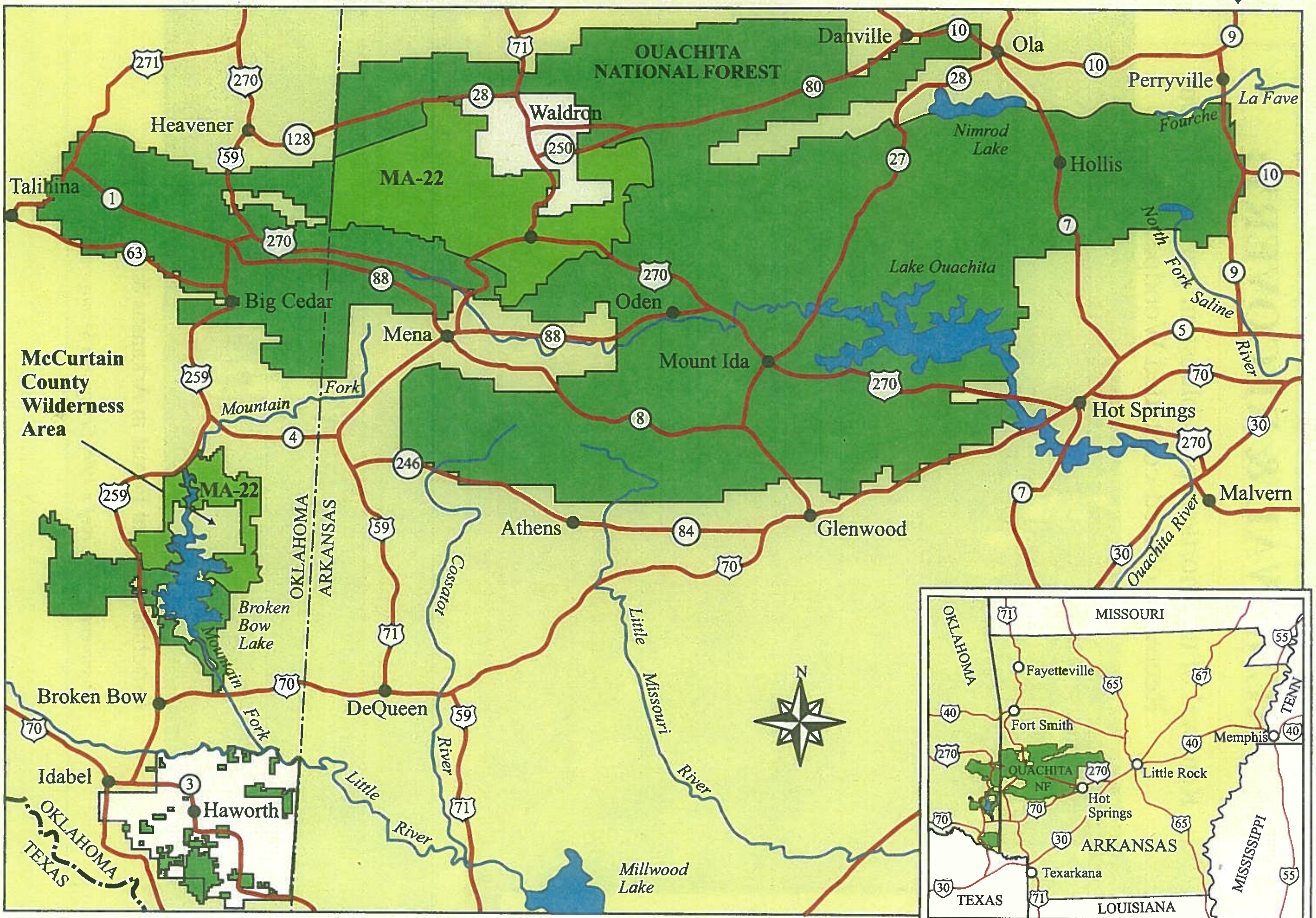
Renewal of the shortleaf pine-bluestem grass ecosystem
Recovery of Red-cockaded Woodpeckers



Ouachita National Forest in Arkansas & Oklahoma

Recipient of the Chief's 1999 Ecosystem Management Award

Ouachita National Forest in Arkansas & Oklahoma
Pine-bluestem Project Management Area 22



Pine-Bluestem Project
Ouachita National Forest

"Pine-bluestem": Shorthand for a habitat dominated by shortleaf pines, bluestem grasses (big bluestem, little bluestem, etc.), and other native plants.

Pine-bluestem project: An effort by the USDA Forest Service, Ouachita National Forest, to restore approximately 200,000 acres of public forestland to conditions that existed in historical times. These public lands are located in western Arkansas on the Poteau, Cold Springs, and Mena Ranger Districts and on the Oklahoma District.

Purpose of the pine-bluestem project: In historical times pine-dominated forests in western Arkansas (and elsewhere) were often open and park-like in appearance. There were mature shortleaf pines, various species of hardwoods, and a lush forest floor carpeted with many other species of plants (numerous grasses, wildflowers like pale-purple coneflower, shrubs, etc.). There was a thriving population of Red-cockaded Woodpeckers, as well as many other species of plants and animals.

Role of fire: Fire played a key role in shaping this open, park-like forest. Fires were caused by lightning, or were set deliberately by either Native Americans or early settlers. They recognized that fire positively affected the plants and animals within the ecosystem. For example, animals that needed grass seeds or grasses for forage or cover benefited from fires that encouraged lush growths of herbaceous plants. Modern research within the pine-bluestem project area supports the ideas held by these earlier Ouachita inhabitants. The Forest Service uses prescribed fire as an indispensible tool in ecosystem renewal.

Renewal and regeneration of the pine-bluestem ecosystem: Like human communities, shortleaf pine forests must change to survive. Also like human communities, these forests are not all of a single age. A healthy forest must include animals and plants (including trees) of many ages. Regeneration of the pine-bluestem ecosystem includes harvesting selected mature trees, cutting some of the smaller trees that tend to become overcrowded in the forest, and prescribed fire. These young stands of trees are important habitat for Neotropical migratory songbirds like Prairie Warblers, Field Sparrows, and Yellow-breasted Chats.

Red-cockaded Woodpecker (RCW) and Bachman's Sparrow: The most well known animal of this ecosystem is the RCW. It became very rare throughout the Southeastern U.S. because of the extensive cutting of old growth pine forests a century ago, and subsequent widespread suppression of the fires that had originally shaped the ecosystem. Without fire, it was virtually impossible for the forest to regenerate into an ecosystem that could support many native species, including Bachman's Sparrow.

The population of RCWs on the Ouachita NF is gradually increasing. Forest Service personnel use many techniques for RCW recovery, including installation of cavity insert nest and roost boxes, banding, and translocation of individual RCWs to the Ouachitas from areas like Texas where the birds are relatively more numerous. The songs of Bachman's Sparrows are now part of the nesting season in the Ouachitas, along with begging calls of nestling RCWs.

Pale-purple coneflower: This beautiful plant is an emblem of the pine-bluestem project area in western Arkansas. It is quite common where this ecosystem has been renewed, but is otherwise uncommon. It grows vigorously in open, park-like forests that are also suitable for RCWs. It is an important plant visited by many insects, including the Diana fritillary.

Diana fritillary: This is the largest and showiest butterfly you're likely to see in western Arkansas. Prior to efforts to renew the pine-bluestem ecosystem, it was considered so rare that it was (and is) on a list of "sensitive species" maintained by the Ouachita NF. In recent years, researchers have located many Dianas within the pine-bluestem project area. This butterfly requires open forest conditions favorable to many native plants, including coneflowers and butterfly weed. These open conditions are also optimal for RCWs, bobwhite quail, and many songbirds.

Northern Bobwhite (quail): This once common and popular species has declined throughout much of its previously extensive range. Renewal of the pine-bluestem habitat with various forest management techniques including prescribed fire has lead to an impressive recovery of local bobwhite populations. Researchers report that food plants needed by this bird, as well as turkey and white-tailed deer, thrive as RCW habitat improves.

FIELD TRIP STOPS - BACKGROUND INFORMATION

1. *Control* –
   a. No recent wildfire or Rx fire, timber harvest, or Wildlife Stand Improvement (WSI)
   b. Adjacent stand – WSI '97; burned 3/28/00; 4/4/02; 2/22/07;4/22/09
   c. Ground cover of dead leaves and needles, dense midstory, and red cedar component present
   d. Benefits some species but not others (e.g. ovenbirds & black and white warblers)
   e. Forest types/condition classes now vs historic. Issue of reversed balance of habitat types.
   f. Slope aspect and vegetation differences

2. *Slab CTC* – RCTC established 10/92; nesting attempts '99,'00 (snake loss),'01,'02,'03,'04,'08,'09; last burns 4/4/02; 2/22/07 & 4/22/09.
   a. RCW items:
      - RCW social structure and habitat needs
      - ONF population trends
      - Translocations including augmentations and 2-bird group initiations (AL;AR;TX;LA;KY/SC)
      - Banding (nestlings; color scheme)
      - Monitoring (nesting; fledglings; pre- and post- translocation)
      - Limits to population growth:
        i. cavity competitors and predators
        ii. low reproductive potential
   b. Other RCW management techniques:
      - SQEDs - Single-strip design was represented here as first of its type on unit to be successfully used for nesting in '02
      - SNEDs
      - Cavity restrictors
      - Artificial cavities (inserts) in conjuction with RCTC concept
      - Landscape scale Rx burning and WSI treatments
      - Cavity maintenance/serviceability issue

3. *Seven Covey Rd. Regen* – (std. 1257/13; birthdate 1989)
   a. Rx burns - 2/4/95; 2/5/96; 1/6/97; 2/14/00; 2/1/03; 4/10/06;4/8/09
   b. No PCT treatment

4. *Seven Covey/Buffalo Rd. Intersection Growing Season Burn* – all prior dormant season burns plus 8/28/02; 4/10/06;4/8/09.

5. *Hicks Burn Regen* – (std. 1257/3; birthdate 1983)
   a. DP foliar spray treatment in 1987
   b. PCT – summer '97
   c. Rx burns – 1988 (site prep); 2/6/92; 2/4/95; 2/5/96; 3/22/97; 1/11/00; 9/25/03 (4-year rough @ time of burn); 4/10/06;4/8/09

6. ***Double-SQED RCW Cavity Tree Cluster*** -
   a. See #2 above for RCW discussion
   b. Example of original 2-strip SQED design (tree now dead and down)
   c. Note restored condition of stand; last timber harvest 1978; no WSI needed here
   d. Dormant season prescribed fire history of every 3 years since spring of 1978 (n=11); last burns 4/22/03; 4/10/06 & 4/8/09
   e. Note slope aspect effect on hardwood vegetation

7. ***Growing Season Burn*** - Since 1978 dormant season Rx burns (n=6) every 3-4 years until 9/13/94 (1st Master's research project growing season burn), and 9/22/97; 9/27/00; 9/25/03; 9/28/06 (n=5 *late* growing season burns). South side of Buffalo Rd. burned 4/25/09.
   a. Important determinants of burning effectiveness are **frequency** and **intensity**, as opposed to **season** of burn. Season of burn influenced distribution & abundance of <10% of species.
   b. Dormant season burns increase legume density and **increase** panicums; growing season burns also increase legumes, but **decrease** panicums.
   c. There is more risk to the overstory with growing season as opposed to dormant season burns.
   d. Prescribed fires easier to control in growing season (usually less wind and higher humidities).
   e. Might use growing season burns more back-to-back (annual burn) where fuel loads have been lowered by prior dormant season burns.
   f. As alternative to growing season burns, fire intensity effects are enhanced by late dormant season burns, which necessitated eliminating the ban on April thru June burning.
   g. Emphasize role of research:
      1) Withgott – black rat snakes
      2) Neal – RCW cavity competitors
      3) Raulston – cavity restrictors
      4) Doster – RCW home ranges and foraging habitat characteristics
      5) Crowder – Translocation & body condition effects on female RCW reproductive success
      6) Jennelle – avian response to precommercial thinned/burned regens & WSI treatments
      7) Briggler – Constructed woodland ponds and associated herps
      8) Huebschmann – economic aspects of pine/bluestem restoration
      9) Luckow – soil nutrients
      10) Thill & Rudolph – herps, lepidoptera and nectar sources associated with restoration
      11) Guldin – regeneration dynamics, pine growth & yield, and economics
      12) Lesmeister – spotted (& striped) skunks
      13) Masters, Lochmiller, et al – pine/bluestem restoration response of:
         - Birds
         - Small mammals
         - Vegetation
         - Quail
         - Deer forage (Increase 6X with WSI; increase 7X with WSI + Rx burning)
         - Growing season vs dormant season burn parameters and outcomes

8. ***Timber/WSI Marking Demo*** -
   a. Same burn regime (dormant season) as surrounding stand (last burns 4/22/03; 4/10/06 & 4/8/09)
   b. <u>**Note:**</u> burns do not routinely control stems greater than 2 inches in diameter

c. Dominant and codominant hardwood reserve trees designated by paint and by description in WSI contract clauses (see WSI contract specs)
d. Pine component to remove is marked with paint
e. All den trees are retained whether or not designated by paint marks
f. Down woody material following WSI treatment is made available as fuelwood, or serves an ecological function
g. Illustrates critical role of timber harvest to ecosystem management by direct consequences and indirectly (i.e. KV funding of subsequent vegetation management activities)
h. **Note:** Only management change between this and control stop is addition of fire; yet midstory persistence restricts herbaceous component.

9. *Mt. St. Helen's Regen* - (std. 1259/13; birthdate 1988)
   a. No PCT treatment
   b. Rx burns – 1987 (site prep); 2/5/95; 1/7/97; 2/14/00; 2/5/03; 3/25/06; 4/8/09
   c. Pole timber stand to west side of this regen stand had HFI timber sale late '04 and midstory treatment 6/05

10. *Preacher's Road/RCW recruitment ctc summer burn* – Burned 8/29/02; 3/25/06. West side of Preacher's Rd. along and to north of Buffalo Rd. burned 6/30/09- as was regen along east side of Preacher's Rd. to north.

11. ***Precommercial thin/burn*** – (std. 1260/8; birthdate 1987; 56 acres)
   a. Stand originated as a seedtree regen cut in the mid-1980's (1984 was original birthdate)
   b. An arson fire set the stand back to "ground zero" in 1987
   c. Top-killed shortleaf pine regeneration recovered by means of basal resprouting (coppice)
   d. 5-6' dog-hair stand of shortleaf pine was precommercial thinned (PCT) in September, 1993
   e. Rx burned (n=5) using backing and spot-firing 2/3/94 (5 months after PCT); ring-fired 1/20/97; 2/28/00; flank-fired 2/5/03; ring-fired 12/14/06.
   f. Hardwood component develops along with dominant pine overstory (important nesting substrate for neotrops)
   g. Rotation burns following PCT maintain open stand structure and herbaceous diversity
   h. Rx fire suppresses pine basal sprouting following PCT
   i. Burning young (5-12 year-old) pine stands extends effective burning season (currently average 2500 to 3000 acres/year of regen burning), and simplifies burning large blocks containing a patchwork of young stands.

12. *Boles Motorway Classic Pine/Bluestem (2 age classes)* –
   a. Diverse herbaceous understory/groundstory present
   b. Commercial thinning; arson fires and rotation Rx burns (dormant season) have occurred since late 70's (last Rx burns occurred 3/15/03 & 2/27/07)
   c. Last commercial timber sale of 6.2 mbf closed 3/30/01
   d. Superficial WSI treatment has been done here
   e. Adjacent regeneration stand has open understory created and maintained by Rx and arson fires which began approximately seven years following stand establishment

f. With rotation burns in mature pine stands, advance pine reproduction will be omnipresent, thus requiring at most one skip of the burn rotation before fire can be reintroduced to maintain an open stand condition.

g. Regeneration issue of single tree selection/UEAM vs seedtree & shelterwood/EAM silvicultural systems

13. Henry Mtn. Seedtree/regen burn – (std. 1262/7; birthdate 1994)

a. Injected '91; 1st burned 1/29/98; N 1/3 burned 1/6/00 & S 2/3 burned 1/11/00; PCT/release summer, '03; 3/7/04; last burned 11/27/06.

b. <u>Note:</u> Top-killed seedlings resprouted similar to the way in which stand of stop #11 was ultimately created (except at stop #11 <u>all</u> of the stand was top-killed).

c. The pine regeneration component is either tall enough to avoid being top-killed by an Rx burn, or if pine stems are not tall enough and are top-killed, they are young enough to express coppice regrowth characteristics and will shortly catch-up with the original stand.

d. A PCT/release treatment in the summer of '03, to adjust pine stocking levels and distribute the desired 10-30% hardwood component, and reintroduction of Rx burning have this stand well on its way to representing a renewed pine/bluestem ecosystem condition.

14. Schrimshire Road Precommercial Thin/Burn - (Std. 1307/15; birthdate 1984)

a. Precommercial thinned 6/97
b. 1st post-thin burn 2/2/98 (KBDI 23)
c. 2nd post-thin burn 3/7/00
d. 3rd post-thin burn 3/19/04
e. 4th post-thin burn 11/3/06
f. 5th post-thin burn 3/17/09

15. Schrimshire Road (#895)/recent landscape scale Rx burn –

a. Three regen stands burned 2/7/98 (area 24R); 2nd burn of progeny test regen std. 3/14/00;
b. Mature stands (area 19W) – north side of road burned 4/3/98; south side burned 3/29/98
c. Benefit of patchwork burning of regen is to maximize fire intensity for each fuel type and simplify burning adjacent mature timber by minimizing amounts of critical line to protect.
d. Two shelterwoods burned 1/29/07 (28 ac. C1307/Std.28 & 21 ac. C1305/Std. 28) and 3/17/09

16. East Horseshoe Road/multiple Rx burned regen – (Std. 1289/12; birthdate 1990)

a. Rx burns – 1989 (site prep); 3/28/95; 1/7/97; 2/4/99; 3/22/01; 2/26/07

17. #515 Road/WSI & loblolly Rx burn – (Std. 1264/3; birthdate 1987)

a. Rx burn 4/4/99

OUACHITA NATIONAL FOREST
RED-COCKADED WOODPECKER BREEDING RECORDS

RCW Breeding Season	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Active Territories	13	16	14	15	16	14	11	13	14	16	21
Nesting Attempts	12	12	13	12	10	12	11*	9	11	11	15*
Estimated Fledglings	10	18	13	14	17	17	16	7	16	14	13
No. of Adult Birds	32	32	32	38	35	34	26	26	24	36	48

RCW Breeding Season	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Active Territories	22	27	32	32 (35*)	35 (38**)	37	40	47	51		
Nesting Attempts	18	24*	27*	28	29 (33*)	32	37	42	47		
Estimated Fledglings	40	40	47	49 (60)	18 (37)	49 (65)	67 (80)	58 (81)	77 (102)		
No. of Adult Birds	51	58	68	78	87	88	103	110	120		

ACTIVE TERRITORIES: A territory is considered active if there are nesting or roosting RCW present.
NESTING ATTEMPTS: When a pair of RCW exhibits nesting behavior which results in at least 1 egg being laid.
ESTIMATED FLEDGLINGS: The # of RCW nestlings that left the natal cavity. (#) = number of ONF nestlings banded that recruitment year.
NUMBER OF ADULT BIRDS: Estimated number of adult RCW present in population prior to nesting season.

* '96 One was a renest, so 1 (C1261/8) of 11 active territories did not attempt to nest.
* '00 One (C1257/22) of 15 nest attempts was a renest, so only 14 of 21 groups attempted to nest.
* '02 Two (C1253/16 & 1243/1) of 24 nest attempts were renests, so only 22 of 27 groups attempted to nest.

* '03 One (C1249/14) of 27 attempts was renest, so only 26 of 32 known groups nested;post-nesting 2 new groups were located-1known to have nested.
* '04 Three recruitment cavity tree clusters (rctc's) became active late in the nesting season
* '05 Of 38 active territories only 29 groups attempted to nest; 4 of the 29 renested following initial nest failures for a total of 33 nest attempts
** '05 Three recruitment cavity tree clusters (rctc's) became active late in the nesting season

(07/29/09 K:\pote\wl\rcw\'90-'09_ONF_breeding_records)

WILDLIFE STAND IMPROVEMENT (WSI)
Contract Specs

TIME OF TREATMENT

All areas with this treatment shall be completed during the leaf-on period, unless changed by COR.

TREES TO BE TREATED

1. Pine trees less than 5 inches DBH will be cut.
2. Hardwoods 1 inch and larger at maximum stump height of 6 inches.
3. Approximately two 9 inch or larger DBH trees (not designated as reserve trees with paint marks on bole or butt) will be girdled with two complete parallel cuts 2-4 inches apart and ½ inches or deeper into the cambium layer.

TREES OR OTHER VEGETATION *NOT* TO BE TREATED

ANY TREE THAT IS MARKED WITH PAINT OR FLAGGING OF ANY COLOR IS TO BE LEFT UNDAMAGED AND UNTREATED.

1. All pine trees with a DBH 5 inches and larger
2. All hardwood trees, regardless of DBH, designated as leave trees by marking with blue, orange or yellow paint on the bole or but.
3. Trees bearing paint (USFS-red) that designate property ownership boundaries.
4. Marker trees bearing survey information and National Forest land ownership signs.
5. Trees that lie directly in or on the banks of streams marked with green paint.
6. Recognizable den trees.
7. Naturally occurring snags.
8. Black cherry, dogwood, mulberry, cedar, plum, redbud, serviceberry, blueberry, hackberry, hawthorn, persimmon, and grape and muscadine vines.
9. Other trees, species, or size class designated by COR/Inspector as work progresses.
10. Trees marked with paint of other colors are either boundary trees, leave trees or are trees that have been sold to timber purchasers. In the event that contractor's operations unnecessarily or negligently result in damage or destruction of these marked trees, contractor shall pay liquidated damages: stumpage value of tree and/or the cost of reestablishing the affected property boundary.

TREE FELLING PROCEDURES

1. All trees selected to be felled (treated) by contract, COR or inspector, will be felled by chainsaws, brush hooks, axes, or other applicable cutting tool.
2. Trees designated for treatment that occur adjacent to roads, pipelines, firelines, fences, and trails will be felled away from those structures. Slash felled in ditches, roadways, or any on any of the structures mentioned will be removed.
3. All trees designated for treatment will be completely severed from the stump by use of chainsaw, brush hook, axe or other applicable cutting tool.
4. Trees which are felled will be cut as close to ground level as practical, but not higher than 6 inches from ground level on the uphill side of the tree. When felled, trees will not be left hanging in or lodged on nearby leave trees.

SHORTLEAF PINE-BLUESTEM RESTORATION IN THE OUACHITA NATIONAL FOREST

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ABSTRACT.— The fire-dependent shortleaf pine-bluestem ecological community, once common in the Ouachita Mountains, had all but disappeared by 1970. This absence was due to the cutting of the original forests in the early part of the 20th century followed by effective fire suppression since the late 1930s. With the adoption of Forest Plan amendments in 1994, 1996, and 2002, and a Forest Plan revision in 2005, the Ouachita National Forest committed to restore the shortleaf pine-bluestem ecosystem on some 250,000 acres. Restoration treatments include thinning pine stands to a residual basal area of about 60 ft^2 per acre, felling most of the woody midstory stems, and prescribed burning at 3-4 year intervals. Achieving conditions similar to those depicted in historic photographs normally requires a thinning, a midstory reduction treatment, and three prescribed fires over about 10 years. Since 1994 some 52,992 acres have been thinned, 42,948 acres have received midstory reduction, and 143,233 acres have received one or more prescribed burns. Managers estimate that some 18,653 acres are presently in a substantially restored condition. During this time the endangered red-cockaded woodpecker (*Picoides borealis* Vieillot) population has more than doubled, and populations of several other previously declining species of conservation concern have increased markedly.

PRE-EUROPEAN SETTLEMENT AND CURRENT ECOLOGICAL CONDITIONS

The Ouachita Mountains of west-central Arkansas and southeastern Oklahoma encompass some 6.6 million acres, and together with the Boston Mountains and Ozark Plateaus to the north and east, comprise the Interior Highlands physiographic region (USDA Forest Service 1999). The Ouachitas are an eroded mountain system that originated in the late Paleozoic period some 280 million years ago through tectonic activity that folded and faulted the ocean sediments of the area from south to north, resulting in an unusual east-west orientation with broad long aspects facing south and north. Elevations range from 500 to 2,700 feet.

Travelers, settlers and scientists in this region during the 1800s and early 1900s described open pine (*Pinus echinata* Mill.) and hardwood forests with floristically rich understory vegetation of grasses and forbs (Nuttall 1999, Jansma and Jansma 1991, Palmer 1924, Little and Olmstead 1931, Cogburn 1976, McBride 1978) (fig. 1). Elk (*Cervus elaphus* L.) and bison (*Bison bison* L.) once found suitable habitat in these open woodland communities (Smith and Neal 1991), and are enshrined in local names such as Buffalo Creek. Fires were common (Nuttall 1999, Featherstonhaugh 1844, Little and Olmstead 1931) and maintained the open condition (Foti and Glenn 1991). In a typical Ouachita Mountain area in Oklahoma, fires occurred at an average return interval of less than 10 years for most sites (Masters and others 1995). Tree densities then averaged 170 trees per acre and the average diameter was 11.4 inches (Kreiter 1995).

While the Ouachita Mountain landscapes of today are still dominated by forests, the composition and structure of these forests are much different. Many hundreds of thousands of

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acres of shortleaf pine-hardwood forests have been converted to loblolly pine (*Pinus taeda* L.) plantations on industry lands. The remaining second-growth stands of shortleaf pine and hardwood today on average have more trees and smaller trees than pre-European settlement stands. Today in the Oklahoma study area, for example, the average number of trees per acre ranges from 200 to 250, and their diameters average 9 inches (Kreiter 1995). Average fire return intervals now range from 40 to more than 1200 years (Masters and others 1995). Throughout the region understory vegetation is now dominated by woody species, and once-common grasses and forbs are scarce (Fenwood and others 1984, Masters 1991, Sparks 1996). Bison and elk have been extirpated. Other species such as Bachman's sparrow (*Aimophila aestivalis* Lichtenstein) brown-headed nuthatch (*Sitta pusilla* Latham) and northern bobwhite (*Colinus virginiana* L.) have been negatively affected by the loss of habitat (Jackson 1988), and the red-cockaded woodpecker has become endangered (Neal and Montague 1991).

Historic and present-day forests of the 1.78 million acre Ouachita National Forest (hereafter ONF) very much fit the descriptions above. The typical shortleaf pine-hardwood stand today ranges from 70-90 years old and is comprised of 90-100 ft^2 basal area of pine, and 30 ft^2 basal area of hardwoods per acre (fig. 2). Of the hardwood basal area, two thirds is in trees 3-9 inches in diameter (Guldin and others 1994). The condition of today's stands derives largely from two factors: the cutting of the original trees and more than 60 years of fire suppression. Large-scale exploitation of the original forests began in the early 1910s and was largely finished by 1940 (Smith 1986). Under Forest Service stewardship, the period of regeneration that followed the cutting was marked by a strict policy of fire suppression that continued well into the 1980s. The ecological upshot is that by about 1970, the shortleaf pine-bluestem woodland community had all but disappeared from the Ouachita Mountain landscapes (Foti and Glenn 1991).

PLANNING FOR RESTORATION

The ONF initiated large scale restoration efforts for the shortleaf pine-bluestem ecosystem with the adoption in 1994 of a forest plan amendment to restore old-growth shortleaf pine stands on some 54,000 acres (USDA Forest Service 1994). This was followed in 1996 by adoption of a forest plan amendment to restore another 120,000 acres of this ecosystem in west-central Arkansas to aid recovery of the endangered red-cockaded woodpecker (USDA Forest Service 1996). In 2002 still another forest plan amendment allocated 30,000 acres in McCurtain County, Oklahoma for recovery of the red-cockaded woodpecker (USDA Forest Service 2002). Finally, a recently adopted revised forest plan (USDA Forest Service 2005) designated an additional 50,000 acres, unrelated to either old-growth forests or red-cockaded woodpecker recovery, to receive restoration treatments. Thus the total acreage allocated to shortleaf pine-bluestem ecosystem restoration is 254,000 acres, about 25% of the total pine-dominated acreage on the ONF and about 14% of the entire forest.

RESTORATION PRESCRIPTIONS

Restoration treatments vary somewhat between stands of native second-growth shortleaf pine and artificial plantations of loblolly pine. In the Ouachita Mountains the latter species was originally naturally distributed in narrow bands along larger stream corridors, mostly along the southern edge of the mountains. However, since the late 1960s the trend on private industrial forest lands has been to replace the shortleaf pine forests on upland sites with loblolly pine plantations, thus increasing its acreage far in excess of its original extent. Some of these former private lands have been acquired for the National Forest system by purchase or exchange. Each of the areas now dedicated to restoration of the shortleaf pine-bluestem ecosystem contains some loblolly pine plantation acreage.

Native Second-Growth Shortleaf Pine

For typical second-growth shortleaf pine stands, the restoration prescription requires thinning to a residual basal area of about 60 ft^2 per acre, felling most of the woody midstory stems in a treatment known within the agency as wildlife stand improvement (WSI), followed by prescribed burning at 3- to 4-year intervals. Overstory hardwoods, mainly oaks (*Quercus spp.*) and hickories (*Carya spp.*), are retained as individuals or clumps within pine stands, and as entire stands throughout the landscape. Flowering trees and fruiting shrubs such as dogwood (*Cornus florida* L.), serviceberry (*Amelanchier arborea* (Michx. f.) Fern.), and wild plum (*Prunus spp.*) are retained during midstory reduction treatments. Implementation of these treatments will result in substantially restored conditions in about a decade (fig. 3).

When stand regeneration is desired, advantage can be taken of shortleaf pine's ability to resprout following fire, a habit noted early on by Mattoon (1915). The repeated prescribed burning should serve to provide advanced regeneration of shortleaf pine through resprouting of existing seedlings as well as recruitment of new seedlings over time. Thus, when a decision is made to regenerate these stands, foresters should be able to rely on release of adequate numbers of seedlings from the advance-growth seedling bank, rather than simply upon seedfall and germination of new seedlings, which can be uncertain in shortleaf pine. Reproduction cutting methods utilizing either irregular seedtree (seedtree with reserves) or irregular shelterwood (shelterwood with reserves) methods will be employed to naturally regenerate these stands. Nominal rotation lengths are 160 years for old-growth restoration units, 120 years in areas managed for red-cockaded woodpecker recovery, and 70 years for the remainder.

Loblolly Pine Plantations

Restoration treatments for loblolly pine plantations include thinning to a residual basal area of about 60 ft^2 of basal area to encourage development of the desired understory grasses and forbs, and prescribed burning at 3- to 4-year intervals to maintain the understory vegetation and discourage loblolly pine reproduction. The loblolly pines will be carried to ages and sizes that are economically efficient. The stands will then be clearcut and replanted with native shortleaf pines, which will then be managed as described above.

The Role for Timber Sales

The ability to sell valuable wood products is at the very heart of restoration efforts regardless of whether the stand currently consists of native second-growth shortleaf pines or planted loblolly pines. All commercial thinning or regeneration cutting is accomplished through the use of timber sales that are advertised and sold to the highest bidder. Further, under authority of the Knutson-Vandenberg Act of 1933 and the National Forest Management Act of 1976, portions of the proceeds from these timber sales are retained to pay for most of the follow-up midstory reduction and prescribed burning needed to restore the stands. The upshot is this: timber purchasers are willing to pay a substantial price for the privilege of cutting and removing trees under the Forest Service restoration prescription, helping us achieve desired conditions across many landscapes. The use of sale proceeds to pay for midstory reduction and prescribed burning reduces the need to rely upon scarce federal appropriated dollars for these treatments, and results in the ability to restore much larger areas than would be possible through expenditure of appropriated dollars alone. In this ecological context, timber sales are a means to an end rather than an end unto themselves.

ENVIRONMENTAL EFFECTS OF RESTORATION

While understanding the essential need for restoration in order to recover the endangered red-cockaded woodpecker (fig.4), and sensing the ecological correctness of restoring an ecosystem that was once widespread but had practically vanished, Forest Service planners and land managers acknowledged that there were unanswered questions about the environmental effects of restoration activities. Studies designed to answer many of these questions were undertaken in cooperation with Oklahoma State University, the University of Arkansas, and the Southern Research Station of the Forest Service. These studies were based on a completely randomized experimental design with 3 to 4 replications depending on the study. All studies included treatments of 1) thinning, WSI and burning with measurements taken one, two, and three years after the burn, and 2) an untreated control. Some of the studies also included a thinning, WSI and no burn treatment. The experimental units were all typical mature second-growth stands of mostly shortleaf pines ranging in age from 70 to 90 years, and averaging about 40 acres in size.

Biological and Physical Environmental Effects

Birds

Wilson and others (1995) studied the effects of restoration on populations of breeding birds. They found populations of 10 species significantly greater in the treatments than the untreated controls, indicating beneficial treatment effects. Among these species are the eastern wood-peewee (*Contopus virens* L.), a declining neotropical migrant, and the brown-headed nuthatch, a non-migratory species of conservation concern. Two neotropical migrant species of concern, the ovenbird (*Seiurus aurocapillus* L.) and black-and-white warbler (*Mniotilta varia* L.) had significantly lower numbers in the treatments than the controls, indicating adverse effects. Some 27 species showed higher but non-significant population numbers in the treatments than in the controls, suggesting the possibility of beneficial treatment effects. Among this group are the neotropical migrants Kentucky warbler (*Oporornis formosus* Wilson), ruby-throated hummingbird (*Archilocus colubris* L.), great-crested flycatcher (*Myiarchus crinitus* L.), yellow-breasted chat (*Icteria virens* L.), common yellowthroat (*Geothlypis trichas* L.), white-eyed vireo (*Vireo griseus* Boddaert), yellow-throated vireo (*V. flavifrons* Vieillot), blue-gray gnatcatcher (*Polioptila caerulea* L.), and prairie warbler (*Dendroica discolor* Vieillot). Other species of conservation concern in this group were the red-cockaded woodpecker, Bachman's sparrow, northern bobwhite, wild turkey (*Meleagris gallopavo* L.), and red-headed woodpecker (*Melanerpes erythrocephalus* L.). Some 10 species had non-significantly lower population numbers in treated stands, suggesting the possibility of adverse effects. Species of conservation concern in this group include the neotropical migrants scarlet tanager (*Piranga olivacea* Gmelin), Acadian flycatcher (*Empidonax virescen* Vieillot), and whip-poor-will (*Caprimulgus vociferous* Wilson). However, in a follow-up songbird study Masters and others (2002) found that the rate of occurrence of the Acadian flycatcher increased in the second and third year post burn treatments as compared to the untreated control. In a subsequent study of northern bobwhites in the restoration area, Cram and others (2002) detected population increases ranging from 5-fold to 19-fold in treated stands as compared to untreated controls, confirming the beneficial effects of treatments on this important game bird.

In yet another study focused on habitat quality for early successional songbirds, Jennelle (2000) concluded that pre-commercial thinning and burning in stands of young trees, and commercial thinning and burning in stands of mature trees, provided suitable foraging and nesting habitat for several such species of conservation concern, including the prairie warbler, yellow-breasted chat, and common yellowthroat. Of special importance was the presence of hardwoods in the shrub layers of both treatments.

In response to restoration efforts and an aggressive translocation program, the red-cockaded woodpecker population has increased from about 32 adult birds and 13 active territories in 1990, to some 88 adults and 37 active territories in 2006 (figs. 5 and 6). Further, 40 or more young have been fledged in 5 of the last 6 breeding seasons (fig. 6).

Mammals

Masters and others (1998) found that populations of small mammals in treated stands increased in abundance and diversity with no species being adversely affected. Total community abundance, richness and diversity were lowest in untreated controls. The authors concluded that restoration efforts may be particularly beneficial to the white-footed mouse (*Peromyscus leucopus* Rafinesque), golden mouse (*Ochrotomys nuttalli* Harlan), and fulvous harvest mouse (*Reithrodontomys fulvescens* Allen), species that may have historically depended on pine-grassland habitats. In a study to determine the effects of restoration on the production of forage for white-tailed deer (*Odocoileus virginianus* Zimmermann), Masters and others (1996) found that preferred deer forage in treated stands was 6 to 7 times greater than untreated controls. Another mammal study currently underway is investigating habitat quality for the eastern spotted skunk (*Spilogale putorius* L.) in shortleaf pine-bluestem landscapes (Leismeister, unpublished data). Restored areas apparently are among the few places in Arkansas where this species of conservation concern can be regularly found.

Other Taxa

Thill and others (2004) studied the effects of restoration on populations of amphibians and reptiles; butterfly fauna and nectar sources; and moth fauna. In most years amphibian relative abundance, richness and diversity were comparable to or higher in restoration treatments than in untreated controls. Overall, values for reptile relative abundance, richness and diversity were numerically greater in the restoration treatments than in the controls, though the differences were generally not statistically significant. Numbers of adult butterflies were lowest in the untreated controls, highest in the treated stands the first year after burning, and intermediate in the second and third years after burning–presumably due to available nectar sources, which exhibited treatment effects nearly identical to numbers of adult butterflies. A butterfly species of conservation concern, the Diana fritillary (*Speyeria diana* Cramer), was significantly more abundant in treated stands. The moth fauna study yielded different results. For late summer and autumn, moth numbers showed a response similar to butterflies with higher relative numbers in the treatments than in the controls. However, the pattern in spring was reversed, with higher relative numbers of moths in the controls. Additional work is necessary to explain these differing seasonal responses.

Vegetation

Sparks and others (1998) identified more than 150 herbaceous species in their prescribed burning study stands that were generally absent from untreated controls. Among these were some 40 species of native legumes whose nitrogen-fixing activities augment soil fertility, and whose foliage and seeds provide an important source of food for wildlife. Species richness increased in restored stands after both late growing season and late dormant season prescribed fires, and was lowest in unburned stands. Overall, herbaceous species richness, diversity, and total forb and legume abundance increased in treated stands as opposed to untreated controls. A key finding in the study is that season of burn influenced the numbers of fewer than 10 percent of the herbaceous species, and none were excluded by season of burning (Sparks and others 1998). It appears that none of the herbaceous species in the Ouachitas depend exclusively on summer burning to maintain their presence in these restored stands.

Soil and Foliar Nutrients

Liechty and others (2005) compared soil chemistry and foliar nutrients of treated stands with untreated controls. Mineralizable N, total N, C, Ca, and pH of surface soils were higher in treated stands than in the untreated controls. Foliar concentrations of N, P, and K were significantly higher in treated stands for at least a year after burning, though only K concentrations remained higher for the entire 3-year post burn period. The authors concluded that surface soil fertility and productivity had improved in treated stands.

Tree Growth

Over 4 years of a study comparing tree growth in restored and untreated controls, Guldin and others (2005) found no significant differences in tree growth between treatments and controls. However, growth in both treated and untreated stands was substantially less than that predicted by a regional shortleaf pine growth model (Lynch and others 1999); observed growth was 70 percent less than predicted by the model in treated stands, and 50 percent less than predicted in the controls (Guldin and others 2005). This unexpected outcome is possibly due to generally drier-than-normal weather conditions during the tree growth study. At any rate, the lower than expected tree growth rates were not due to treatment effects.

ECONOMIC EFFECTS

Before considering the economic effects of restoration treatments, it should be understood that there is no law requiring that National Forest lands be managed for profit. In fact, there is specific language in the National Forest Management Act of 1976 directing that managers should not select treatments based on a "greatest return" criterion. Nevertheless, in describing economic effects, it is useful to couch them in terms of opportunities foregone. This will give private landowners an idea of costs and returns should they be interested in applying these restoration prescriptions.

Huebschmann (2000) used an input-output model to estimate the economic effects of shortleaf pine-bluestem restoration for red-cockaded woodpecker recovery over a 100-year simulation period for a 155,000-acre study area in Scott County, Arkansas. He compared present net value (PNV) for the area if managed under the restoration prescription with a 120-year rotation and low tree density, to what its PNV might be under a more traditional management prescription with a 70-year rotation and heavier stocking. He estimated that after 100 years the PNV for the restored area would be $111 million less than the PNV for the area had it been managed in a more traditional manner. This translates into an opportunity cost of about $9.25 per year for each acre of pine in the study area. Most of this opportunity cost is attributable to the fact that old pine trees, of which there are many more on the landscape under a long-rotation restoration prescription, do not grow as fast as younger trees. The economic model was based on present average stumpage value for pines, and thus overestimates the economic costs if the future value of large old trees is significantly greater, which is a distinct possibility. At this point, there is no reason to believe that an area managed under a restoration prescription would produce any dramatically different economic value than an area under traditional management provided that the rotation lengths are the same.

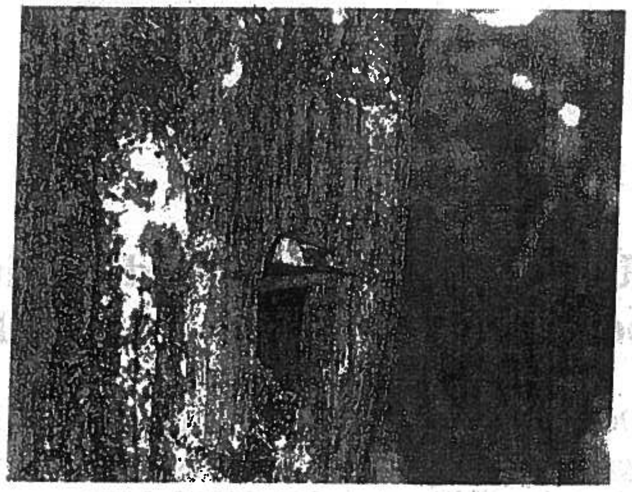
RESTORATION PROGRESS AND FUTURE CHALLENGES

From the work that began in the late 1970s as a treatment applied to a few acres surrounding red-cockaded woodpecker cavity tree clusters, the restoration efforts today have burgeoned to encompass landscapes at a scale of hundreds of thousands of acres. Since the adoption of the first formal shortleaf pine-bluestem restoration decision document in 1994, the Ouachita National Forest has thinned 52,992 acres, conducted mid-story reduction treatments on 42,948 acres, and applied prescribed burning at least once on some 143,233 acres within restoration areas. Managers estimate that 18,653 acres are currently in a substantially restored condition.

However, because of the scale of the undertaking, there are significant challenges to achieving restoration objectives. Ultimately, almost 85,000 acres will likely have to be burned annually in order to maintain desired conditions in the restoration areas. State smoke management plans currently being implemented in Arkansas and under development in Oklahoma may limit the acreage that can be ignited in a single burn, and/or limit the total acreage that can be burned in a single day. Too, the Forest's work force is aging, with fewer individuals each year able to meet the physical fitness requirements for prescribed burning. These changes could make it more difficult to burn sufficient acreage each year. Though herbicides have been used only sparingly to date, their use might have to be increased substantially if prescribed burning capability erodes. Further, prescribed burning which has historically been done only by Forest Service employees might have to be done by outside contractors.

SUMMARY

This conservation effort, which had its first stirrings as a concern for an endangered species on a few scattered parcels of land, has grown with public support to encompass a commitment to restore a quarter million acres–a pace and a scale scarcely imaginable 15 years ago. It proceeds by utilizing elements of landscape ecology and restoration ecology supported by local research results published, for the most part, in peer-refereed scientific journals. It promises to substantially restore an ecosystem that was once widespread but is now rare. It offers the opportunity to develop self-sustaining populations of an endangered species and several other species of conservation concern that are presently underrepresented on the landscape. At the same time, the work maintains all of the traditional human uses of the land from logging and firewood gathering to hunting, hiking and camping. This work enjoys the support of the conservation and lumber manufacturing communities, in addition to the general public. It integrates all of the conservation laws that govern management of National Forest lands. Finally, we and others think it restores an aesthetic beauty to the land not seen in many decades. As a result, we believe this work serves as an example of ecosystem renewal and as a showcase for appropriate management of National Forest lands.



SELECTED ABSTRACTS

- **Cram, D.S., R.E. Masters, and F.S. Guthery, D.M Engle, and W.G. Montague. 2002. Northern Bobwhite population and habitat response to pine-grassland restoration. J. Wildl. Manage. 66:1(1039.**

NORTHERN BOBWHITE POPULATION AND HABITAT RESPONSE TO PINE–GRASSLAND RESTORATION

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Abstract: We compared northern bobwhite (*Colinus virginianus*) abundance and habitat characteristics in unmanaged mixed shortleaf pine (*Pinus echinata*)–hardwood stands and restored pine–grassland stands managed for the red-cockaded woodpecker (*Picoides borealis*) on the Ouachita National Forest, Arkansas, USA. To determine northern bobwhite (hereafter, bobwhite) population response in untreated control, thinned, and thinned and burned stands either 1, 2, or 3 growing seasons (Mar to mid-Oct) post-burn, we used whistling-male counts and covey-call counts as indices of population abundance. We estimated woody stem density, understory and overstory canopy cover, conifer and hardwood basal area, and the disc of vulnerability to characterize habitat response. Relative abundance of whistling males in the spring was greatest in thinned stands 3 growing seasons post-burn and in thinned but unburned stands. These stands had the smallest disc of vulnerability and the greatest understory shrub cover <2 m in height compared with other treatments. A threshold-like increase in bobwhite abundance was observed as a function of woody structure <2 m. Pine–grassland restoration provided suitable structure for bobwhites in spring, summer, and fall, but may not be adequate in winter. Further, data suggested that bobwhite density within a stand also was related to the amount of suitable habitat surrounding the stand. Bobwhite management efforts in similar shortleaf pine forests should include thinning to reduce midstory and overstory cover and frequent fire to maintain open woodland conditions—i.e., low basal area stands with limited midstory.

-----DRAFT-----

Usable space versus food quality: testing bobwhite habitat management hypotheses

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Abstract: We examined 2 hypotheses commonly used to manage northern bobwhite (*Colinus virginianus*) habitat: 1) usable space and 2) habitat quality, specifically food quality and quantity. To evaluate these hypotheses, we studied the response of bobwhite foods (plants and invertebrates), usable space and populations following thinning and burning on the 60,000-ha pine (*Pinus* spp.)–grassland restoration area in the Ouachita National Forest, Arkansas. To determine bobwhite population response we used whistling-male counts as an index of population abundance. Relative abundance of whistling males in the spring was greatest in thinned but unburned stands, and thinned stands 3 growing seasons post-burn. We estimated invertebrate food abundance using sweep nets and plant food abundance using herbaceous and woody stem counts of food-producing plants. Richness, density, and frequency of occurrence of bobwhite food-producing plants increased following thinning and fire. Relative abundance, mass, and frequency of occurrence of invertebrate foods also increased following thinning and fire. Relative invertebrate abundance and mass apparently increased up to ± 3 years as a function of time since fire. Important fall and winter food plants, especially tick trefoil (*Desmodium* spp.) and bush clover (*Lespedeza* spp.) legumes, increased in density and frequency of occurrence following thinning and fire. We found food supply following pine–grassland restoration was a function of usable space. Food abundance alone did not characterize bobwhite population response. By comparing stands where usable space and bobwhite abundance were similar, we observed an apparent threshold region where an increase in bobwhite food supply had a minor effect on bobwhite abundance. Food abundance was therefore not considered a limiting factor for bobwhites following pine–grassland restoration.

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RESEARCH ARTICLE

Reptile and Amphibian Responses to Restoration of Fire-Maintained Pine Woodlands

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Abstract

Fire-maintained woodlands and savannas are important ecosystems for vertebrates in many regions of the world. These ecosystems are being restored by forest managers, but little information exists on herpetofaunal responses to this restoration in areas dominated by shortleaf pine (*Pinus echinata*). We compared habitat characteristics and herpetofaunal communities in restored pine woodlands to relatively unmanaged, second-growth forests in the Ouachita Mountains of western Arkansas, USA. We found woodland restoration with periodic burning affected species differently; some species benefited, some species appeared negatively affected, but most species did not respond clearly either way. Overall reptile captures were significantly ($p = 0.041$) greater in pine-woodlands than in unrestored forest; one species of snake and three species of lizards were captured more often in woodlands than unrestored forests. Among anurans, we found no significant difference in captures between woodlands and unrestore[…] forests for any species. Among salamanders, we capture[…] western slimy salamanders (*Plethodon albagula*) almo[…] exclusively in unrestored forest, but captures of oth[…] species did not differ between the two treatments. Histor[…]cally, the Ouachita region likely consisted of a mosaic th[…] included both fire-maintained habitats (woodlands, sava[…]nas, and prairies) and areas of denser forest on mesic sit[…] that were less likely to burn. Consequently, landscap[…] that retain both open woodlands and denser, less-intense[…] burned forest (in the form of unharvested greenbelts […] separate stands) would likely promote and maintain […] greater diversity of herpetofauna.

Key words: amphibians, Arkansas, burning, fire, habit[…] restoration, herpetofauna, Ouachita Mountains, reptile[…] savanna, woodland.

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Influence of Ecosystem Restoration for Red-cockaded Woodpeckers on Breeding Bird and Small Mammal Communities

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Abstract.—Shortleaf pine-bluestem (*Pinus echinata* Mill.-*Andropogon* spp.) restoration for red-cockaded woodpeckers (*Picoides borealis*) has been underway for more than 2 decades on the Ouachita National Forest, Arkansas. Restoration efforts consist of modifying stand structure to basal areas similar to presettlement times and reintroduction of fire. This is accomplished through midstory and codominant tree removal (wildlife stand improvement -WSI) and dormant season prescribed fires on a 3-year cycle. Concern has been expressed about the influence of this type of management on non-target species, specifically small mammals and breeding birds. Control stands (no thinning or fire) were characterized by closed canopies and dense midstory with little understory vegetation. WSI-treated stands were characterized by open canopies, little midstory and an increase in herbage production by 3-7 fold depending on whether or not stands had been burned and time since the stands had been burned. Woody cover after WSI followed a predictable increase with additional growing seasons since prescribed fire. Total community abundance, species richness, and diversity of small mammal and breeding bird communities were dramatically increased by restoration. No small mammal species were adversely affected by restoration treatments. Pine-grassland obligate songbirds increased following WSI and many of these showed significant increases directly attributable to fire. Bird and small mammal habitat associations are also described.

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Small mammal response to pine-grassland restoration for red-cockaded woodpeckers

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Abstract The U.S. Forest Service plans to restore >40,000 ha of the fire-dependent shortleaf pine (*Pinus echinata*)-grassland community on the Ouachita National Forest and potentially >780,000 ha of the pine-grassland community throughout the Southeast to benefit the endangered red-cockaded woodpecker (*Picoides borealis*). Concern has arisen over impacts of large-scale conversion of closed-canopy forests to open pine-grassland woodlands. We evaluated how an ecosystem approach to habitat improvement for the red-cockaded woodpecker affected small mammals. During 2 winters we compared small mammal occurrence and abundance in untreated pine-hardwood stands to stands following wildlife stand improvement (WSI; midstory removal), and with WSI-treated stands in the first, second, and third dormant seasons following prescribed fire. Total abundance of small mammals was highest in WSI stands and was a more direct response to WSI (change in stand structure) than to fire. Increased species richness and diversity in the second year of this study was strongly related to both WSI and fire. No species was adversely affected by WSI or by fire. Rather, WSI and fire-reduced midstory, increased dead debris in the understory, promoted herbaceous production, and increased woody sprouting. Total community abundance, richness, and diversity were lowest in untreated stands. White-footed mice (*Peromyscus* spp.; primarily white-footed mouse [*P. leucopus*]) were the dominant species, accounting for 68% of the 611 individuals collected. Restoration efforts may be particularly beneficial to generalist species such as *P. leucopus* as well as to more specialized species, such as golden mouse (*Ochrotomys nuttalli*) and fulvous harvest mouse (*Reithrodontomys fulvescens*) that historically may have depended upon pine-grassland habitats. Restoration of pine-grassland communities may enhance small mammal communities by reestablishing a landscape element that was present during presettlement times.

Key words Arkansas, fire ecology, Ouachita Mountains, *Picoides borealis*, pine-bluestem, prescribed fire, red-cockaded woodpecker, small mammals, wildlife stand improvement

Historic evidence suggests that fire-maintained, shortleaf pine (*Pinus echinata*)-grassland communities were characteristic of the presettlement Ouachita Mountain region (Foti and Glenn 1991, Masters et al. 1995) and that open-woodland or pine-grassland habitats were once prevalent across the southeastern United States. (Christensen 1981, Buckner 1989, Waldrop et al. 1992). The endangered red-cockaded woodpecker (*Picoides borealis*) is an endemic species of southern pine-grassland forests.

Management of red-cockaded woodpeckers has been approached on an ecosystem basis since 1990 in the Ouachita National Forest. Use of wildlife stand improvement (WSI; midstory removal) and prescribed fire was broadened to restore shortleaf pine-grassland communities. Midstory removal is fol-

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BREEDING BIRD RESPONSE TO PINE-GRASSLAND COMMUNITY RESTORATION FOR RED-COCKADED WOODPECKERS

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Abstract: Plans exist to restore the fire-dependent pine (*Pinus* spp.)-grassland community in Ouachita National Forest and potentially throughout the southeastern United States to benefit the endangered red-cockaded woodpecker (*Picoides borealis*). Restoration and management techniques include wildlife stand improvement (WSI; thinning of midstory and codominant trees) and prescribed fire. We evaluated how habitat improvement for the red-cockaded woodpecker affected other breeding bird species. We compared avian species frequency of occurrence and abundance during 2 breeding seasons in untreated pine-hardwood stands with that in treated stands after WSI and in 3 growing seasons following WSI and prescribed fire. Total bird densities were highest ($P = 0.087$) in the second growing season following WSI and fire and lowest in the control, whereas species richness did not differ ($P = 0.399$) among treatments. Densities of ground/shrub-foraging and shrub-nesting species increased ($P = 0.002$ and 0.002, respectively) the most following WSI and fire. Only ground-nesting species were more abundant ($P < 0.001$) in untreated stands than in treated stands. Restoration efforts may be beneficial to neotropical migrant species such as eastern wood-pewee (*Contopus virens*) and prairie warbler (*Dendroica discolor*), in addition to declining species of regional interest such as red-cockaded woodpecker, Bachman's sparrow (*Aimophila aestivalis*), and northern bobwhite (*Colinus virginianus*) that depend upon pine-grassland habitats.

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Reintroduction of Fire Benefits Breeding Birds in Pine-Grasslands (Arkansas)

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In 1991, the U.S. Forest Service and others began an effort to increase the abundance of the endangered red-cockaded woodpecker (*Picoides borealis*) by restoring the historic open structure of a shortleaf pine-bluestem grass (*Pinus echinata-Andropogon* spp.) community on a 155,000-acre site southeast of Fort Smith, Arkansas in the Ouachita National Forest. Once a common ecosystem in the Ouachita Mountains of Oklahoma and Arkansas, pine-grassland communities have rapidly changed to closed-canopy pine forests after a century of fire suppression and other disturbances (Masters and others 1995). Using historical documents, photographs and fire history studies, we developed a plan that consisted of: 1) thinning the midstory and co-domi trees, also called Wildlife Stand Improvement (WSI) an burning on a three-year cycle.

Stands in WSI-treated sites consist of a pine-dominated c story, an open midstory, and a dense understory of slash, hardw sprouts, vines, grasses, and forbs. Woody shrubs initially decr following fire, but become the dominant component of the un story by the third postburn season (Figure 1). During the r burn cycle, fire topkills small-diameter sprouts, thus maintair an open midstory. However, public concern has been expre about the effect of burning on non-target breeding birds.

We therefore assessed breeding bird communities in trea and untreated areas, first in 1992 and 1993 (Wilson and otl 1995) and again in 1999 and 2000, using specific orthogc contrasts to separate the effects of thinning alone and the eff of fire on the bird community. We quantified the breeding b community over the four-year period using fixed-radius pc count plots in 73 stands (after Hutto and others 1986), a grouped species into three habitat designations: forest inter forest edge (including some open forest species), and pine-gr land (Wilson and others 1995).

We observed 68 species of breeding birds in all treated a control stands over the course of our study. The overall b

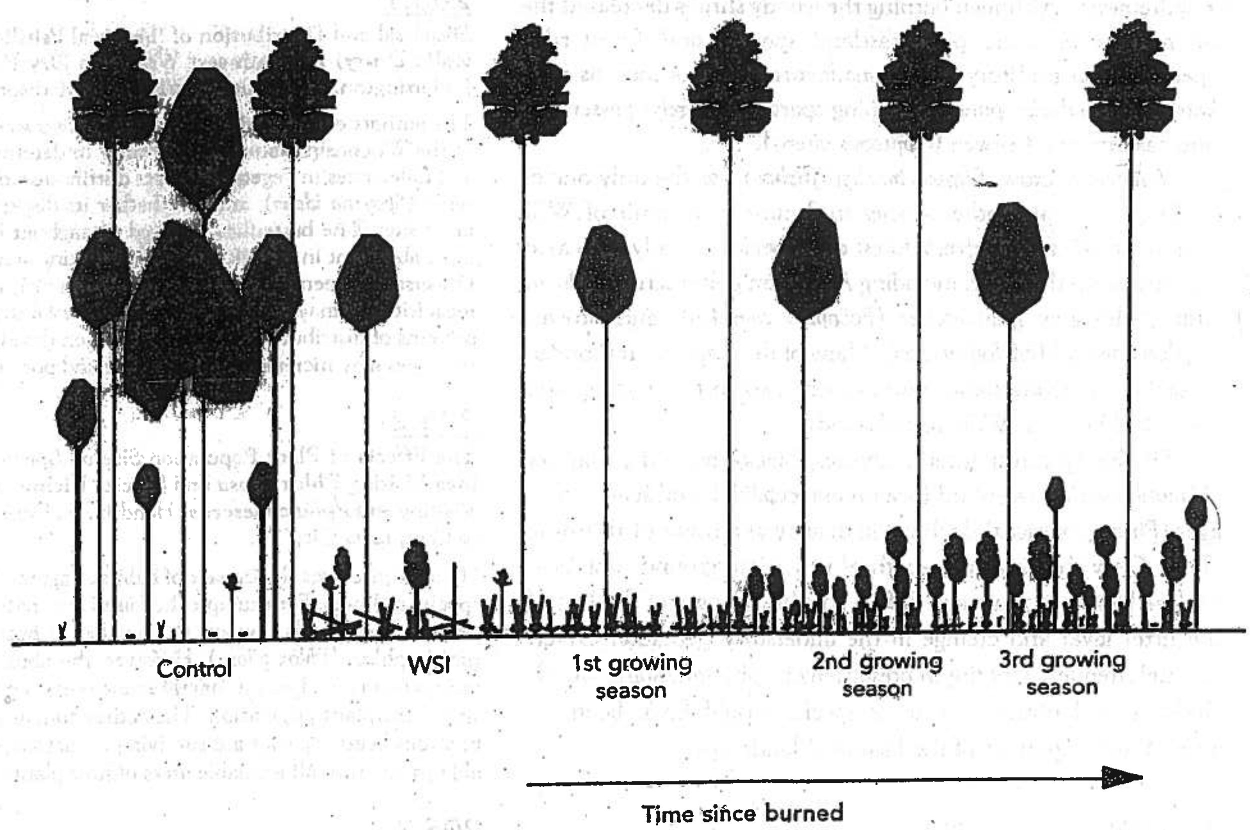

Figure 1. Plant succession following thinning of midstory and co-dominant trees, or Wildlife Stand Improvement (WSI), and prescribed burns the Ouachita National Forest near Fort Smith Arkansas. The open midstory following treatment creates brief windows of suitable habitat f some pine-grassland bird species. By the third postburn season, woody shrubs dominate the understory.

community composition did not change from the first study period to the last. However, restoration treatments dramatically increased total community abundance, species richness, and diversity of breeding bird communities. When we analyzed bird species-habitat relationships, we found that individual species habitat preferences varied across the broad continuum from closed-canopy, pine-oak forest to open, pine-grassland woodlands. Although bird community composition differed somewhat between WSI stands and control stands, species composition in WSI and WSI/burned stands were nearly identical (97+ percent).

Of the seven priority species (Pashley and others 2000) that occurred in the treated stands, whip-poor-will (*Caprimulgus vociferous*) was the only one that showed even a tendency to be detrimentally affected by restoration treatments. All 10 pine-grassland obligates, including priority species such as Bachman's sparrow (*Aimophila aestivalis*), brown-headed nuthatch (*Sitta pusilla*) and prairie warbler (*Dendroica discolor*), increased in either density or frequency of occurrence following either thinning or thinning and fire.

Several species were distinctly associated with the woody structure that developed as plant succession progressed following fire. This created a brief window of suitable habitat for some pine-grassland species, such as indigo bunting (*Passerina cyanea*), and slightly longer windows for species with broader habitat requirements. Although burning the woody shrubs decreased the abundance of some pine-grassland species and forest-edge species, open midstory conditions favored species such as pine warbler (*Dendroica pinus*), chipping sparrow (*Spizella passerina*), and eastern wood pewee (*Contopus virens*).

American crow (*Corvus brachyrhynchos*) was the only one of 35 forest edge and other species to decline as a result of WSI treatment. We found several forest edge species actually increased in response to thinning, including American goldfinch (*Carduelis tristis*), blue-gray gnatcatcher (*Polioptila caerulea*), and brown-headed cowbird (*Molothrus ater*). Many of these species responded favorably to woody sprout development two to three years after prescribed burns in WSI-treated stands.

Of the 22 forest interior species, black-and-white warbler (*Mniotilta varia*), ovenbird (*Seiurus aurocapillus*), and scarlet tanager (*Piranga olivacea*) declined in density as a result of thinning alone. Only the first two—both of which are ground nesters—declined directly as a result of fire, possibly because of the loss of the litter layer and change in the understory structure. Given the high frequency of fire in presettlement pine-grassland woodlands, it is doubtful that these species would have been an important component of the historical landscape.

Acknowledgments

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FROM: Abstracts of the 10th Annual Prairie Invertebrate Conference

205.1

Dispersal and Distribution of the Regal Fritillary Butterfly (*Speyeria idalia Drury*) in Southwest Wisconsin Dry Prairies. Beilfuss, K. and J. Harrington, University of Wisconsin-Madison, Madison, WI 53706.

The authors established a grid system in two southwest prairie preserves of the Wisconsin Nature Conservancy to determine 1) how topography and differences in vegetation affect distribution of the regal fritillary butterfly (*Speyeria idalia*), and 2) whether its dispersal occurs between disjunct sites. The butterflies occurred throughout both preserves but were more abundant in forb-rich areas frequenting areas with low shrub cover. Dispersal between disjunct sites occurred in only one prairie. Because the regal fritillary may be fire sensitive in its larval stage, taking into account patterns of distribution and dispersal when developing fire-management strategies may increase its survival rate and potential for recolonization.

205.2

The Effects of Plant Population Size on Species Richness of Butterflies Visiting *Phlox pilosa* and Species Richness of Insect Herbivores Visiting *Amorpha canescens*. Hendrix, S., Dept. of Biology, University of Iowa, Iowa City, IA.

Hendrix discusses the impact of habitat fragmentation on prairie insect species richness. For example, he found that reduction in plant population size negatively impacts the number of butterfly species that visit prairie phlox (*Phlox pilosa*). However, the abundance of insect herbivores visiting leadplant (*Amorpha canescens*) is not as closely tied to the size of the plant population. The author concludes that only some herbivorous beetle species are surviving as metapopulations. Others seem able to colonize all available areas of host plants.

205.3

Butterflies as Bioindicators of Habitat Quality on Conservation Reserve Program Parcels. Lloyd, M.R. and P.K. Kleintjes, Dept. of Biology, University of Wisconsin-Eau Claire, Eau Claire, WI.

Effects of pine-grassland restoration for red-cockaded woodpeckers on white-tailed deer forage production

Ronald E. Masters, Christopher W. Wilson, George A. Bukenhofer, and Mark E. Payton

Abstract We determined the effects of management for red-cockaded woodpecker (*Picoides borealis*) on white-tailed deer (*Odocoileus virginianus*) forage production on pine–oak sites in the Ouachita Highlands of western Arkansas. Wildlife stand improvement (WSI; thinning of midstory and some codominant trees) and burning were primary management techniques used for woodpecker habitat improvement. We compared other grass, panicum (*Panicum* spp.), sedge (*Carex* spp., *Scleria* spp.), non-legume forbs, legumes, preferred woody, non-preferred woody and total standing crop response during 2 years in untreated pine–hardwood stands with that in treated stands after WSI and in 3 growing seasons following WSI and prescribed fire. Plant groups contributing to deer forage (panicum, sedge, forb, legume, and preferred woody standing crop) were increased by WSI 6-fold and by WSI and fire >7-fold over control stands (434–520 kg/ha versus 69 kg/ha). The standing crop of preferred woody browse was ≥20% of total standing crop in all stands, and was increased by 4–9 times by WSI or WSI and fire. Wildlife stand improvement alone increased herbaceous plant production. Fire further enhanced forb and legume production but initially caused declines in panicum, low-preference woody, and total woody standing crop. Total standing crop was up to 6 times greater on WSI-treated stands than control treatments (988 vs. 159 kg/ha), and this response was related to stand basal area and time since burned. Management of stands for pine-bluestem renewal should be patterned after presettlement landscape conditions using growing and dormant season burns and a periodic burn interval versus set 3-year dormant season burns. We recommend retaining mature oak-pine stands on mesic sites for acorn production within a mosaic of WSI and burned sites that dominate on xeric sites.

Key words forage production, forest management, *Odocoileus virginianus*, *Picoides borealis*, prescribed fire, red-cockaded woodpecker, white-tailed deer, wildlife stand improvement

The endangered red-cockaded woodpecker (*Picoides borealis*) is considered a keystone species of once prevalent pine (*Pinus* spp.)-grassland ecosystems in the southeastern U.S. (Ligon et al. 1986, Brennan et al. 1995). Fire played a prominent role in maintaining this unique community across the southeast (Waldrop et al. 1992), especially in the Ouachita Mountains of Arkansas and

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Influence of fire season and fire behavior on woody plants in red-cockaded woodpecker clusters

Jeffrey C. Sparks, Ronald E. Masters, David M. Engle, Mark E. Payton, and George A. Bukenhofer

Abstract The control of woody midstory vegetation in red-cockaded woodpecker (*Picoides borealis*) clusters is a major concern throughout southeastern United States pine (*Pinus* spp.) forests. Prescribed fire and midstory thinning are the most common management tools used to restore pine-grassland communities and minimize midstory development; however, it is unclear which season of fire is most efficient for their use. We compared woody-stem control from prescribed fires during September and October (late growing season; before leaf fall) with that from March and April (dormant season; before leaf expansion). Mortality of woody stems ≥1 m tall was related ($P<0.002$, $r^2 \geq 0.64$) to the fire-behavior parameters of fireline intensity, rate of spread, and heat/unit area. During September-October, fires were less intense ($P<0.05$) than during March–April, and less effective ($P=0.042$) in reducing woody stems 1–3 m tall in the understory and lower midstory. Because of prolific sprouting, neither season of prescribed fires eliminated stems <1 m tall. March to April fires were most effective, in the short term, in controlling midstory encroachment. We recommend that studies using prescribed fire quantify fire behavior rather than using subjective descriptions and precisely define season (month) of burn along with describing plant phenology.

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Journal of Vegetation Science 9: 133-142, 1998

Effects of late growing-season and late dormant-season prescribed fire on herbaceous vegetation in restored pine-grassland communities

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Abstract. We compared the effects of late dormant-season and late growing-season prescribed fires on herbaceous species in restored shortleaf pine- (*Pinus echinata*) grassland communities in the Ouachita Highlands of western Arkansas. Herbaceous species richness, diversity, and total forb and legume abundance increased following fire. Late growing-season burns reduced distribution and abundance of panicums (primarily *Panicum boscii*, *P. dichotomum*, and *P. linearifolium*) while late dormant-season burns increased *Panicum* distribution and abundance. Density of legumes (such as *Stylosanthes biflora*) increased following frequent or annual dormant-season fires. However, season of fire influenced the distribution and abundance of fewer than 10 % of the species. Fire plays an essential role in pine-grassland communities by creating and maintaining open canopy conditions that perpetuate understory herbaceous plant communities.

- **Masters, R.E., D.M Engle and R. Robinson. 1993. Effects of timber harvest and periodic fire on soil chemical properties in the Ouachita Mountains. SJAF 17:139-145.**

Effects of Timber Harvest and Periodic Fire on Soil Chemical Properties in the Ouachita Mountains

Ronald E. Masters, *Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln Blvd., Oklahoma City, OK 73105 and Department of Zoology, Oklahoma State University, Stillwater, OK 74078;* **David M. Engle,** *Division of Agricultural Sciences and Natural Resources, Oklahoma State University, Stillwater, OK 74078; and* **Ray Robinson,** *Oklahoma Department of Wildlife Conservation, P. O. Box 202, Clayton, OK 74536.*

ABSTRACT. *Soil chemical properties on mountainous terrain in oak-pine forests of southeastern Oklahoma changed following timber harvest and prescribed fire. Differences were related to residual stand characteristics, prescribed fire regimen, and vegetation change following site perturbation. Available NO_3-N, Ca, and P significantly increased on harvested and burned sites, and on clearcut, windrowed, and summer burned sites compared to untreated sites. Nitrate levels were statistically unrelated to a 2,690% increase (7 to 190 lb/ac) in legume standing crop across site treatments. Nitrate levels were low, and these sites may be nitrogen limited. No increase was found in soil pH. Effects of burning harvested sites on most soil chemical properties generally persisted less than 2 yr. A timber harvest-fire interaction on levels of available K and Mg was evident 4 yr posttreatment. Timber harvest, periodic prescribed fire, and subsequent plant succession redirected nutrient cycling pathways and enhanced soil nutrient levels. Enhanced nutrient regimes are ecologically advantageous for stand reinitiation and recovery following site perturbation or natural disturbance. South. J. Appl. For. 17(3):139-145.*

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Bearded Skeletongrass *Gymnopogon ambiguus* Buffalo Road area

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501-321-5202

Poteau RD P.O. Box 2255 Waldron, AR 72958
479-637-4174

Cold Springs RD P.O. Box 417 Booneville, AR 72927
479-675-3233

Mena RD P.O. Box 220 Mena, AR 71953
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