Pushmataha Forest Habitat Research Area

TALL TIMBERS
RESEARCH STATION

Influence of Timber Harvest and Fire Frequency
on Plant Community Development, Wildlife, and Livestock

Integrated Land Management Options

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Purpose of Project

To evaluate a range of forestry, range management and wildlife management practices and their influence on wildlife habitat.

To compare potential land management options for integrated wildlife, forestry and livestock objectives.

To demonstrate several sustainable land management options for eastern Oklahoma landowners.

Objectives

1.   Determine practices that increase habitat quality for deer, elk, rabbit and quail.

2.   Determine the effects of fire and fire frequency on plant succession and nutrient cycling.

3.   Determine the effects of fire and fire frequency on post oak and blackjack oak acorn production, crown vigor and mortality.

4.   Provide economic analysis of various land management options.

Acknowledgements

Pushmataha Forest Habitat Research Demonstration Area

Project History

The Oklahoma Department of Wildlife Conservation established the Pushmataha Forest Habitat Research Demonstration Area (FHRA) in 1982 to evaluate herbaceous and woody vegetation responses to a variety of timber harvest and prescribed fire regimes, and to determine possible forest management alternatives for large-scale application on Wildlife Management Areas. This 130-ac area is on the 19,000-ac Pushmataha Wildlife Management Area (WMA), Pushmataha County, Oklahoma (Figure 1). Pushmataha WMA lies in mountainous terrain along the western edge of the Ouachita Highland Province. The WMA was initially established as a deer refuge in the 1940's. Elk were released on the area in 1969. The Pushmataha WMA supported 15 elk in 1988 and 27 elk in 1994 (Masters 1991*a*, Masters et. al. 1997). Currently the WMA supports about 40 elk. Elk have localized near the FHRA possibly because of the availability of open areas of various types as a result of the timber management program. The Pushmataha WMA supported an average density of 8.7 deer/km^2 (SE=0.4) (22.5 deer/mi^2) from 1986 to 1990 (Masters et al. 1993*a*). An outbreak of epizootic hemorrhagic disease in 1993 lowered the deer population to <5 deer/km^2 (12.9 deer/mi^2). Rabbit populations have not been monitored other than through pellet count data on the FHRA. Plots were laid out and fire guards bladed in 1982. Before any treatment was applied, a baseline vegetation study was conducted. Herbaceous and woody stem density and percent cover data was collected along with basal area data.

Forestry Services began support of this project in 1992. This project is currently supported by Oklahoma Department of Agriculture Forestry Services through a Forest Stewardship grant, Oklahoma Department of Wildlife Conservation and the Oklahoma Agricultural Experiment Station and Tall Timbers Research Station.
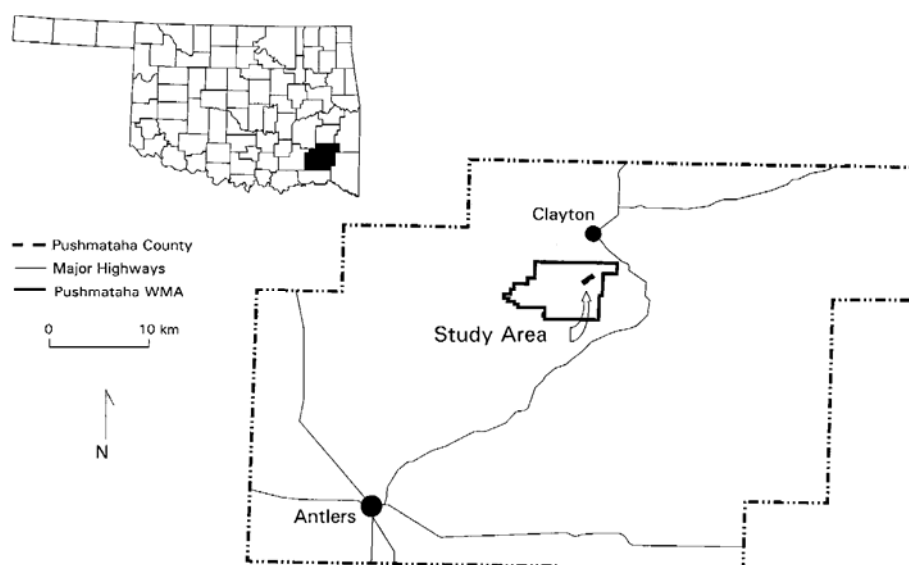

Figure 1. Location of the Pushmataha Forest Research Demonstration Area.

Cultural Treatments

During summer 1984, merchantable pine timber was harvested in scheduled treatments, and hardwoods selectively thinned to approximately 9-m^2/ha (39.2 ft^2/ac) basal area (BA) by single-stem injection using 2,4-D. Prescribed burns using strip-head fires were conducted in winter 1985 and in succeeding years at defined intervals (Masters and Engle 1994).

Nine treatments were applied to 28, 1.2- to 1.6-ha (2 to 4 ac) units in a completely randomized experimental design, beginning in summer 1984. Cultural treatments and number of replications (N) are summarized as follows (See Figure 2):

1) control, no treatment (N = 3);
2) rough reduction, winter prescribed burn (**RRB**) - 4-year interval, 1985, 1989, 1993, 1997, 2001, 2005 (N = 3);
3) harvest pine timber only, winter prescribed burn, 1-year interval (**HNTI**), beginning in 1985-present, except 1995 (N = 3);
4) harvest pine timber, thin hardwoods, no burn (**HT**) (natural regeneration to a mixed stand; N = 3);
5) harvest pine timber, thin hardwoods, winter prescribed burn - 4-year interval (**HT4**), 1985, 1989, 1993, 1997, 2001, 2005 (N = 3);
6) harvest pine timber, thin hardwoods, winter prescribed burn - 3-year interval (**HT3**), 1985, 1988, 1991, 1994, 1997, 2000, 2003, 2006 (N = 2);
7) harvest pine timber, thin hardwoods, winter prescribed burn - 2-year interval (**HT2**), 1985, 1987, 1989, 1991, 1993, 1996, 1997, 1999, 2001, 2003, 2005 (N = 3);
8) harvest pine timber, thin hardwoods, winter prescribed burn - 1-year interval (**HT1**), beginning in 1985-present, except 1995 (N = 3); and
9) clearcut, summer burn - 1985, contour rip 1986, planted to loblolly pine (*P. taeda*) 1986, winter burn 1998, thin summer 2001, Jan. burn 2002 (**CCSP**) (N = 3).

Peripheral supplemental forage openings [1.2 to 4 ha (2 to 10 ac)] were included to compare use of a traditional wildlife management technique with those under development. Inclusion of this additional treatment is valid in a completely randomized experimental design (Steele and Torrie 1980:126, 139). The food plot treatment is summarized as follows:

10) cultivated, fertilized food plot, planted to fescue, rye, vetch, and Korean lespedeza (**FP**); plots were mowed each fall and disked periodically (N = 3).

We also began collecting data on a treatment, referred to as pine-bluestem that has been implemented since the start of the research project and has gained considerable attention from landowners, natural resource professionals, and restoration ecologists alike.

11) thin hardwoods, winter prescribed burn at 1-year interval beginning in 1985-present, except 1995 (N = 1) (**PBS**).

Figure 2. Pushmataha Forest Habitat Research Demonstration Area.

Methods

Application of Treatments

Beginning in summer 1984, 10 treatments were applied to 28 1.2- to 1.6-ha (2-4) units in a completely randomized experimental design (See page 6 for treatment). During summer 1984, merchantable pine timber was harvested in assigned treatments, and hardwoods were selectively thinned by single stem injection using 2,4-D to an approximate basal area of 9 m^2/ha (39.2 ft^2/ac). Prescribed strip-head fires were applied on appropriate units in winter 1985 and in succeeding years at 1-, 2-, 3-, and 4-year intervals. Fireline intensity of March 1988 burns ranged from 628-903 kW/m (Masters 1991b:280). Subsequent burns have ranged from 50-3,100 kW/m. The clearcut site preparation treatment included shearing, raking, and windrowing of logging debris with a site preparation burn conducted during summer 1985. After contour ripping, genetically improved loblolly pine (*P. taeda*) seedlings were planted on a 2.1- x 2.4-m (7- x 8-ft.) spacing in early April 1986. In 2001, a post/salvage thinning was completed on these units for the purpose of reducing average basal areas from about 26.4 m^2 /ha to 20.7 m^2/ha (115 ft^2/ac to 90 ft^2/ac) to promote increased growth.   Initially the sale was for a post thinning (commercial) but an ice storm in December 2000 damaged a fair number of trees (Masters 2001).

Sampling Methods

We sampled vegetation in September and October of each year, coinciding with a critical period of nutritional stress for deer in the Ouachita Mountains (Fenwood et al. 1984). On each treatment unit, we established 10 permanent plots at 20-m (66 ft or 1 chain) intervals on 2 randomly located lines perpendicular to the contour. To avoid bias caused by influences from adjacent treatment units, we did not sample within 20 m of any edge (Mueller-Dombois and Ellenberg 1974:123).

Basal Area and Canopy Cover.--Basal area of overstory vegetation was quantified each year using the variable radius plot method (Avery 1967:165-168). Basal areas of stems $\geq$5 cm (2 inches) in diameter at breast height (DBH) were measured with a 10-factor wedge prism at each permanent plot location. Baseline sampling was conducted before cultural treatment application in 1983. Overstory canopy cover was determined with a 9-point grid in a sighting tube with vertical and horizontal levels at plot center and cardinal points at 2 m (6.6 ft) and 4 m (9.1 ft) from each permanent plot location (Mueller-Dombois and Ellenberg 1974:89).

Standing Crop.--We measured herbaceous and woody standing crop by the harvest method (Cook and Stubbendieck 1986:52-53) in the first 2 weeks of September 1986-1990 and the last week of September to the second week in October for 1992-2001, 2003, and 2005 within 0.5- x 0.5-m (0.25 m^2) (1.6- x 1.6 ft or 2.7 ft^2) quadrats. Current year's growth of vegetation was clipped to <2.5 cm (1 in) height and hand separated into sedge, legume, panicum (primarily those that form winter rosettes), other grasses, forb, and woody categories. Woody growth was clipped to a height of $\leq$1.4 m (4.5 ft). Litter was collected down to mineral soil and included dead grass, leaves, bark fragments, and twigs <2.5 cm diameter. Samples were dried to constant weight at 70 C (158 F) in a forced air oven. Size and number of quadrats were determined by Cain and Castro's (1959:167-174) minimal area concept to derive species-group area curves. Subsample sizes ranged from 5-15/experimental unit.

Previous work with enclosures on sites adjacent to the FHRA suggested that deer densities >8/km^2 (20.7/mi^2) may affect forage standing crop estimates in unenclosed areas (T. Silker, Oklahoma State Univ., Stillwater, unpubl. data). Deer density estimates on our study area from 1985-1990 were $\geq$ 8/km^2 (Masters 1991b:83,191). Effects of cervid herbivory on standing crop estimates were assessed by harvesting paired plots in and out of movable cages (area = 0.4 m^2, ht = 0.7 m) (area = 4.3 ft^2, ht = 2.3 ft) along randomly located transects in 1987-1989 (Oosting 1956:39, Cook and Stubbendieck 1986:56). Cages were moved to new locations each March. Sampling in enclosures were abandoned in 1991 after subsequent analysis revealed that cervid herbivory was having no effect on forage production or herbage composition (Masters et al. 1993b).

Mast Trees.--We selected three post oaks and three blackjack oaks, where available, as study trees from each treatment unit, following commercial pine harvest in 1984. Initially we sought to include black oaks as well but given the paucity of this species on the study area

and unequal distribution only a few were available and chosen for monitoring. Black oaks did not occur in all units or even treatments.

On each unit, all hardwood trees of the appropriate species were systematically examined before selection. Those selected must not have been damaged by commercial timber harvest, in terms of canopy breakage or bark damage from felled trees or skidders. Further, trees were evaluated based on canopy development, height and diameter at breast height (DBH). Available trees of the appropriate species in the dominant or co-dominant position in the canopy were selected over intermediate or suppressed trees. However, some of the selected blackjack oaks were in intermediate canopy position as these were all that were available. The best-formed and most vigorous appearing trees were selected from candidate trees. As well, trees on harvested units had to have complete crown release from competition and were generally greater than 20 m from the nearest residual tree. All potentially competing residual trees greater than 5 cm in diameter that were less than 20 m distant were single stem injected as described earlier. We chose to select trees based on specified criteria rather than at random because we were evaluating the response of mature trees to full crown release and fire in order to evaluate the validity of the current forest management strategy for determination of leave trees in timber harvest units. Therefore, the same protocol was followed on our treatment units. Variables included for measurement included age, species, DBH, total height, crown area, and crown density. Measurements were taken every year until 1989 and at the least every two years thereafter. Mortality was tracked each year.

We measured age by obtaining an increment core at DBH. Samples were mounted on 2.5 X 2.5 X 40 cm wooden blocks and air dried for > 1 month. Samples were then sanded using 440 grit sandpaper and rings counted after a suitable viewing surface was obtained. DBH was measured to the nearest 0.1 cm using a standard diameter-tape (Forestry Suppliers). We used a clinometer to measure total tree height to the nearest 0.5 m at 20 m distance. In 2002 and 2003 a laser height measuring device was used to measure to the nearest 0.1 meter height (Forestry Suppliers).

To estimate crown area, we measured crown diameter at two perpendicular axis and then calculated area based on the formula for the area of an ellipse whose semiaxes are a and , $A = \Pi ab$. To assess crown density, we estimated canopy cover beneath each sample tree from mid September to mid October prior to leaf abscission with a 9-point grid in a sighting tube with vertical and horizontal levels at cardinal points ½ the distance from the tree bole to canopy edge from 1999 to 2005.

Post-burn measurements after the first prescribed burn included bark char height and height of limb scorching using a loggers tape or a clinometer as suitable. Residual bark char prevented remeasurement in succeeding years. During later burns fire behavior was sampled and fireline intensity was calculated and reported by Masters and Engle (1994).

Acorn Sampling--We also evaluated acorn production and viability from 1984 to1989 and in 1998. We used 18.93 liter buckets with an opening diameter of 28.96 cm for an

effective trap area of 658.52 cm². We checked acorn traps at 1 week intervals beginning in early September until acorn drop was completed, generally late November during each sampling year. Acorns were bagged and the green weight and number of acorns recorded. We also recorded the percent of acorns that were sound. We extrapolated total acorn production of viable acorns for each tree based on the crown area and percent of crown sampled.

      Northern Bobwhite Sampling--We evaluated Northern Bobwhite population response during the fall vegetation sampling period based on incidental sightings as sampling work was performed. These estimates were compared with hunter estimates and locations of coveys throughout the course of the hunting season. They were also compared with incidental records obtained during prescribed burns during the late-dormant season and early growing season. These data have been tracked since 1983 and although not rigorous in methodology are useful as an indication of trends.

Data Analysis

      The Kruskal-Wallis nonparametric test was used to test for treatment differences ($\underline{P} <$ 0.05) in standing crop, basal area, and canopy cover estimates between treatments (SAS Inst. Inc. 1985:651). When data were analyzed across years, the year X unit X treatment Type III mean square was used as the error term. Multiple comparisons between mean ranks were made with Tukey's test with alpha = 0.05 (Conover and Iman 1981). Pearson correlation coefficients were calculated to examine the relationship between total standing crop and basal area, canopy cover, litter accumulation and months since burned (SAS Inst. Inc. 1988:126).

      Effects of herbivory on standing crop were determined with a 2-tailed paired $\underline{t}$-test to compare caged and uncaged standing crop estimates (Steel and Torrie 1980:90; SAS Inst. Inc. 1985:799, 1988:235). When differences between uncaged and caged plots were not significant ($\underline{P} > 0.05$), plots were combined for analysis of treatment effects.

      Unit means were summarized for all other measurements and summary statistics presented graphically or in tabular form. Northern bobwhite abundance was summarized by standard summary statistics only and graphically represented for years when observations were collected.

Results and Discussion

Forge Production

      Grass production remains highest on annually burned treatments. Although the HNTI treatment has about 40% of the original canopy cover, grass standing crop is still quite high. Those treatments with high canopy cover and infrequent burning (4 year intervals) have much lower production. Panicum (*Panicum, Dicanthelium*) basal rosettes are an important winter forage for deer, elk and rabbit. Not all panicums form these rosettes. Generally panicum production is low on all treatments except the HNTI areas. This is reflective of several

sample plots falling within a drainage dominated by warm season panicums such as switchgrass (*Panicum virgatum*) and others. Sedge standing crop varies somewhat but is similar in most treatments except for the clearcut and rough reduction burn treatments. Very little sedge production was found in the clearcut units. However the rough reduction burn units had 3 - 9 times the sedge standing crop, possibly because of the periodic burning and presence of overstory. Fire reduces the litter layer but the unharvested overstory still provides needed shade. Sedges are also as important winter browse for deer, elk and rabbit.

Many studies across the Southeast have demonstrated dramatic increases in legumes following either fire or thinning or a combination of both. Our results confirm this as well. Annual burn treatments had the highest legume production and control treatments the least. Legumes are important for quail, turkey, deer and rabbits.

Forb standing crop was similar on all treatments except the annually burned treatments which were 4 - 6 times higher. Still forb production is less than 10 percent of total standing crop. Forbs are imported for a wide variety of wildlife species from songbirds to mammals.

Woody standing crop (<1.4 m in height) was current annual growth only. This indexes only that portion likely to be used by browsers (deer, elk, rabbit). It was highest in the HT4 treatment and lowest in the control. Fire obviously promotes some sprouting by hardwoods and shortleaf pines. Woody production declines as fire frequency increases. Our only exception was the HT3 treatment, which had been burned the previous dormant season.

Total standing crop was highest on the units with partial overstory removal and fire. Fire and timber harvest play an important role in putting forage on the ground for deer, elk and rabbit and the development of cover. Litter weight was highest on units with a well developed overstory and lowest on the open burned units.

Effects on Trees

a)
Total Basal Area 1983-2005
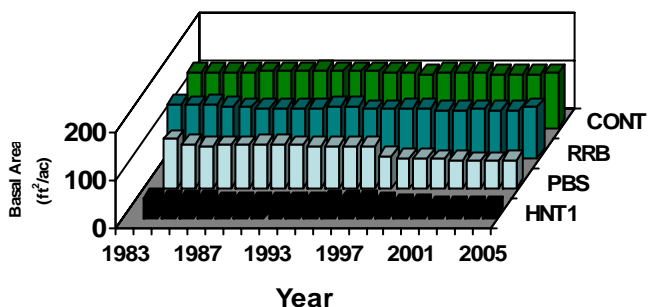
b)
Total Basal Area 1983-2005
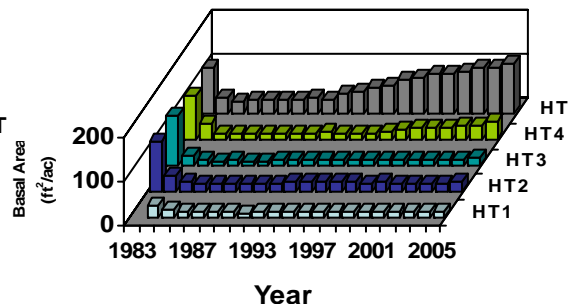
c)
Pine Basal Area 1983-2005
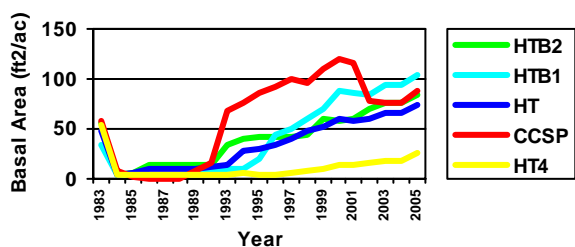
d)
Cedar Basal Area 1983-2005
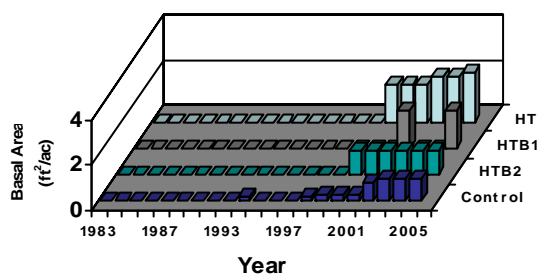
Figure 3.   Change in total basal area (ft^2/ac) in response to pine timber harvest, thinning of hardwoods and periodic fire on Pushmataha Forest Habitat Research Area 1983-2005.

a)
Canopy Cover 1985-2005
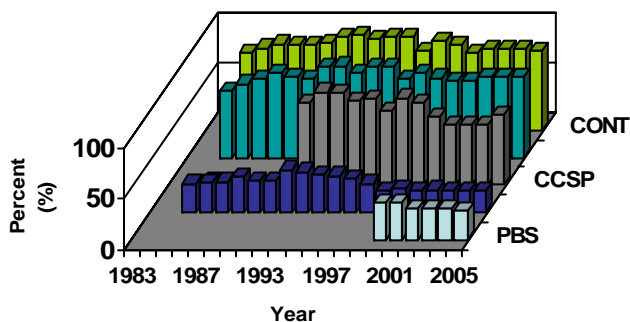
b)
Canopy Cover 1985-2005
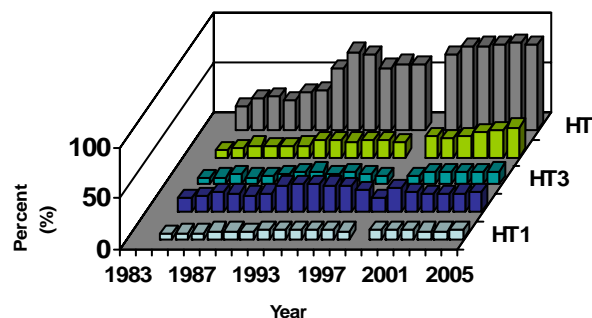
Figure 4.   Change in canopy cover (%) in response to pine timber harvest, thinning of hardwoods and periodic fire on Pushmataha Forest Habitat Research Area 1985-2005.

Mast Trees

No additional mortality had occurred at the time of sampling during 2005. At this point total mortality among the 83 trees selected for this study is 25 for 30.1% (Figure 5). Fire has caused mortality to 15.7% of the trees. A total of 10 blackjack oak trees (12.1%) have succumbed to hypoxylon canker. All of these have occurred on treatments not thinned. Lightning has struck 3 post oaks but has killed only 2 (2.4%) (Figure 5). No black oaks have died during the course of this study; but those on burned units are declining in vigor.

Upon examination of annual survival rates (Figure 6), we find that cumulative mortality was significant in the first and second year following introduction of fire for post and black jack oaks. This pulse of mortality was related to high amounts of residual logging slash and related fire behavior. Prescribed burns were observed to be intense in spots and residence time lengthy because of the amount of 10 hour fuels that were present and burned. Also the proximity of slash to some of the selected trees predisposed them to mortality through crown scorch and lethal heat levels at the base of the stem.

The fire behavior variables that best predicted mortality based on preliminary analysis (Masters and Waymire 2001) were DBH class, fire presence or absence, bark char, crown area and tree height. In other words smaller trees were more susceptible (lower diameter, height and crown area). Subsequent mortality for blackjack oaks has been almost entirely from hypoxylon canker in control units and RRB treatments and has accelerated in the past 5 years (Figure 6). Control units have experienced 75% mortality to blackjack oaks from hypoxylon canker (Figure 5 and 7). A higher proportion of blackjack oak mortality is from disease rather than fire (Figure 5). This is thought to be a result of competition and late summer drought stress.
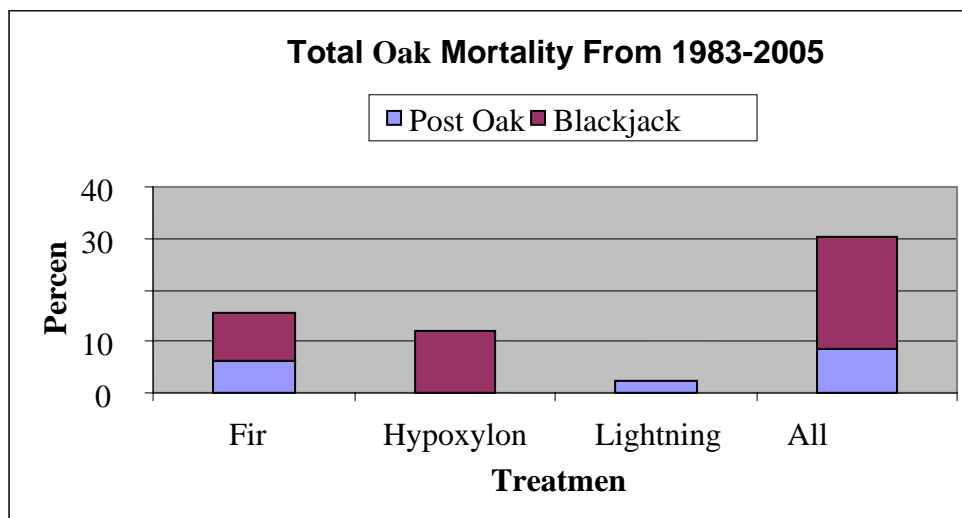
Figure 5.   Cause-specific mortality of selected post oaks and blackjack oaks on Pushmataha Forest Habitat Research Area from 1983-2005.
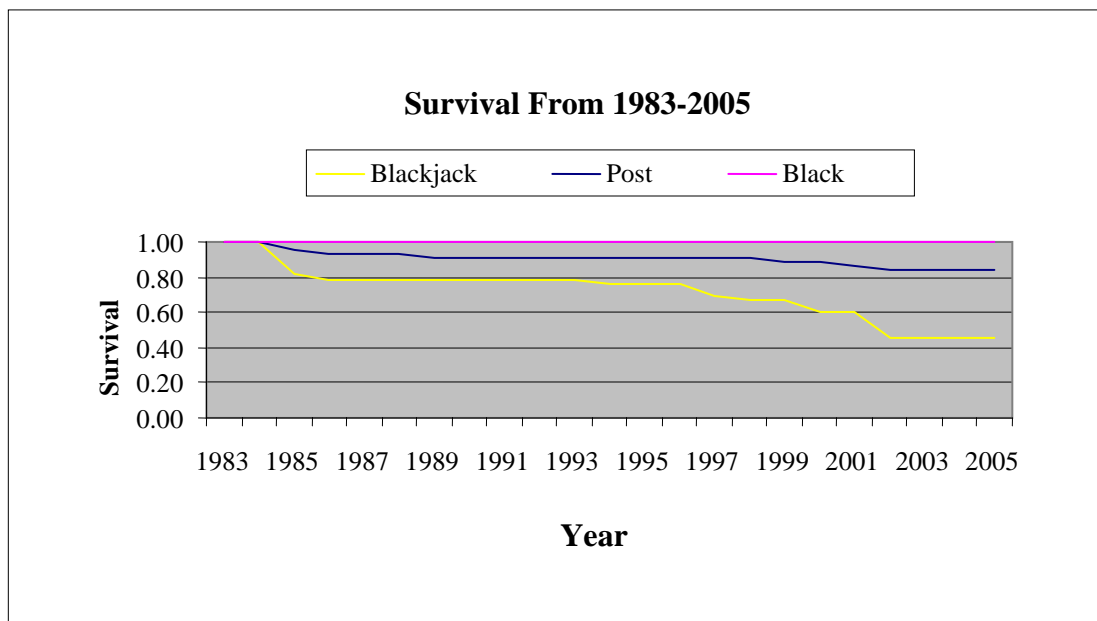
Figure 6.   Yearly survival rates for all selected post oaks, blackjack oaks and black oaks on all treatments on Pushmataha Forest Habitat Research Area from 1983-2005.

High mortality on HT4 treatments is a result of the initial prescribed fire used on 1 unit where flame heights and fire intensity were greater and is not necessarily an indication of treatment (burn cycle) effect (Figure 5, 6, 7 and 8). The 2 post oak trees killed by lightning occurred on the HT4 and HT3 treatments. No post oaks have died on control, rough reduction or the HT (seed tree) units (Figure 8).
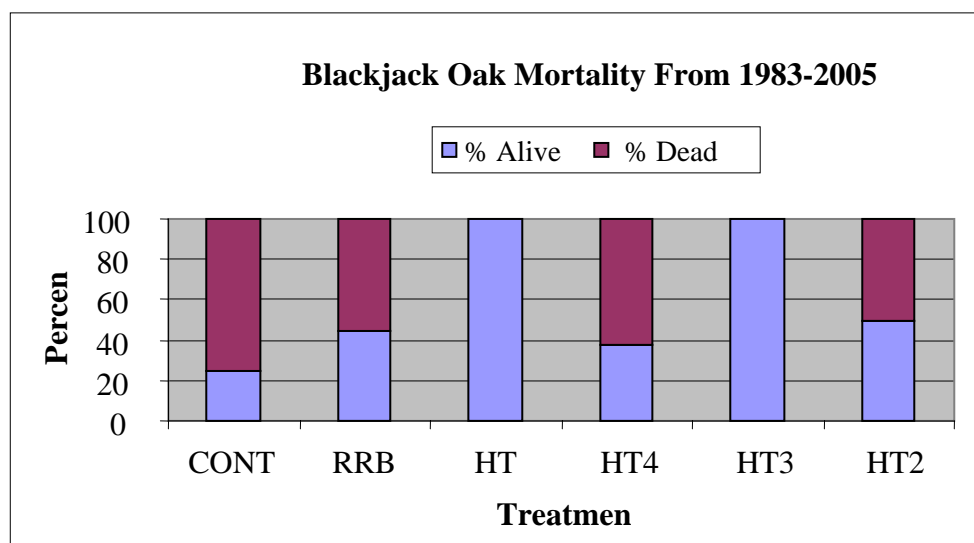
Figure 7.   Percent mortality of selected blackjack oaks by treatment on Pushmataha Forest Habitat Research Area from 1983-2005.

Post Oak Mortality From 1983-2005
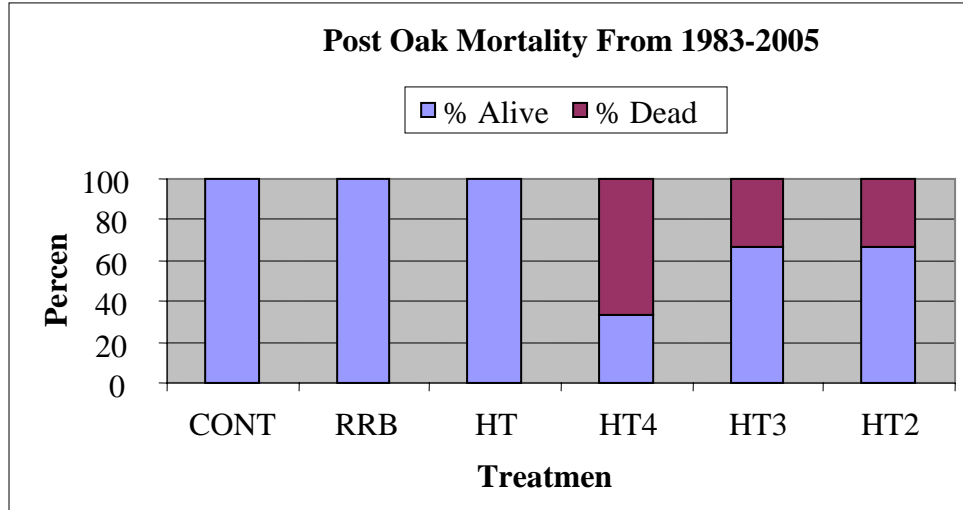
Figure 8.   Percent mortality of selected post oaks by treatment on Pushmataha Forest Habitat Research Area from 1983-2005.

Our results suggest at this point that high initial fire intensity (i.e., the first burn) has a negative effect upon survival of post oaks. Further, small diameter blackjack oaks are more susceptible to fire but competition for moisture may be the most critical issue for survival, as drought stress has predisposed this species to hypoxylon canker.

Northern Bobwhite Response

Bobwhite population response has varied a great deal on this small study area over the course of this study (Figure 9). Before the study began, the fall population density was estimated at less than 1 bird/125 acres. It is clear that the combination of treatments has created usable space and suitable habitat where none existed before. However, useable space has declined on several of the treatments as a result of change in vegetation structure as plant succession proceeds in a different fashion based on fire frequency. Initially HT, HTB1,HTB2, HT4 and CCSP treatments provided usable space, of these the CCSP and HT4 provides marginal usable space currently. The population response, in part, may also be related to the sequence and percent of the area burned in a given year. Northern bobwhites are also known to respond to weather conditions during nesting season in spring and summer. The long term average population has been 1 bird/4 acres considering the entire study area. However, when only usable space is considered the population long term average is 1 bird/2 acres. This is important to note because *the area is not specifically managed for quail*. This set of treatments clearly shows that management of the overstory through thinning and use of frequent prescribed fire to manage the understory has a dramatic effect on quail populations. This area shows the potential on private and public lands for recovery of declining bobwhite populations across the southeast U.S.

Northern Bobwhite Response
on Pushmataha FHRA (130 ac)
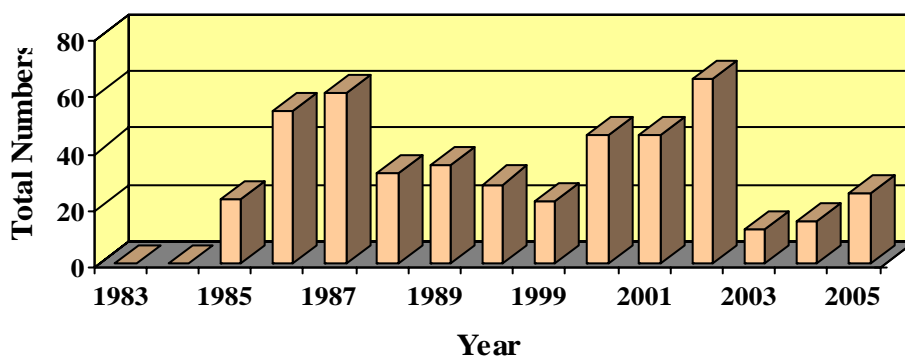
Figure 9. Northern bobwhite response based on fall flush counts on the Pushmataha Forest Habitat Research Area (FHRA) Fall 1983-2005.

Application of Treatments

Control – unharvested, unthinned, unburned

Photo after harvest and thinning, March 1985

Post-burn on harvested and thinned treatment.

Six months after burning, September 1985.

Control

Control

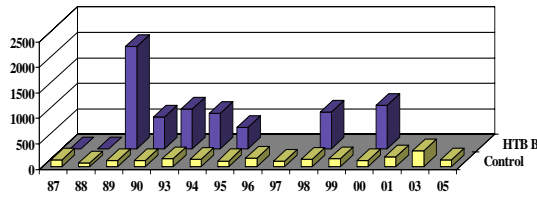### Total Biomass (Kg/ha)
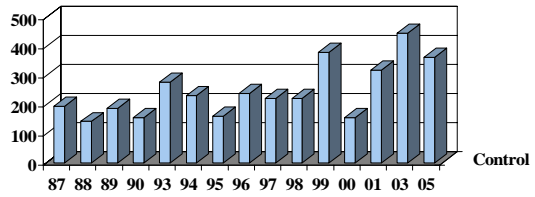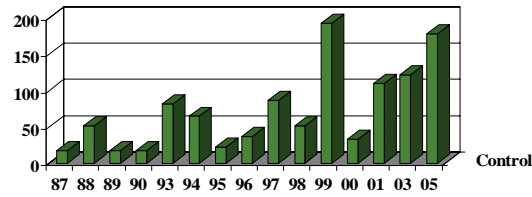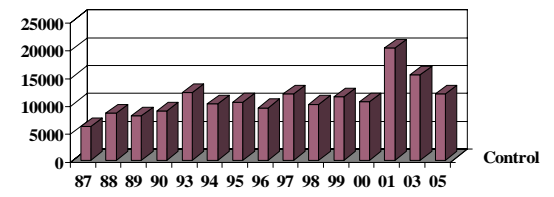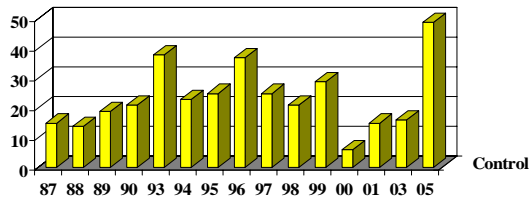
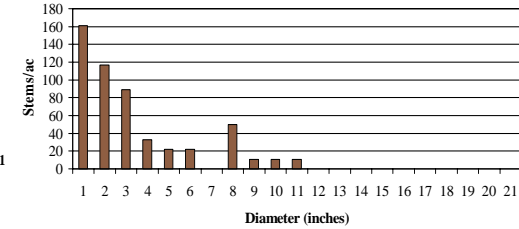### Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)
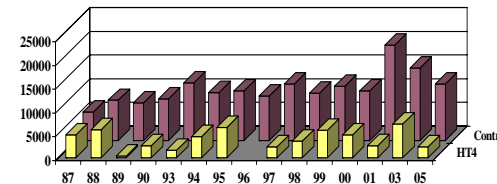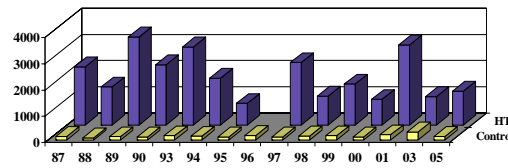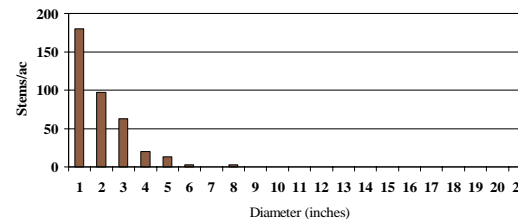

Sedge, Panicum, and Grass Biomass (Kg/ha)
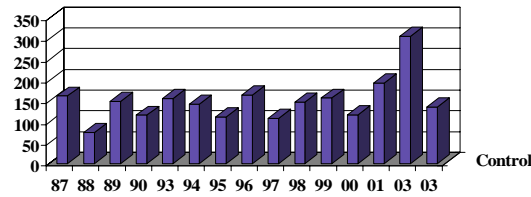
Pine Diameter Distribution, 2001
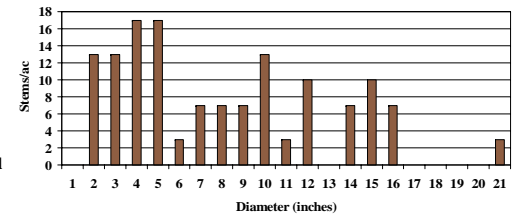
Woody Stem Density, Fall 2004
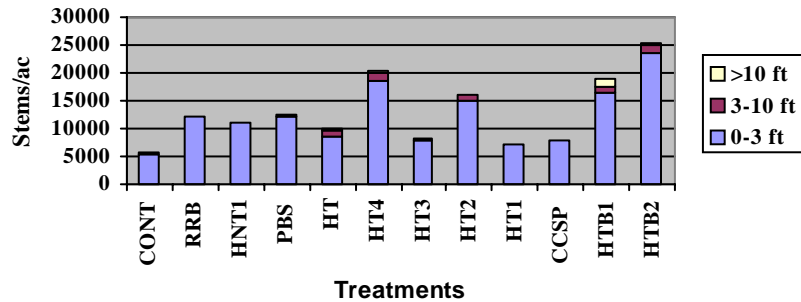
Basal Area Change 1983-2005
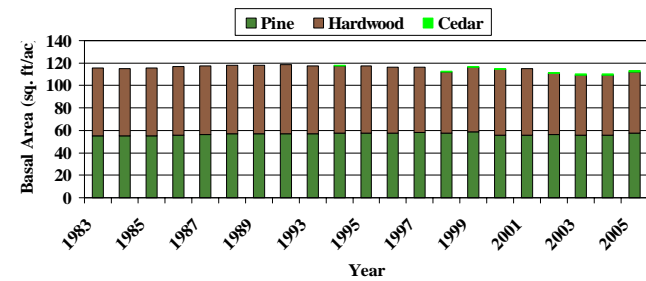
RRB (Rough-reduction burn)

RRB

Burned late winter 1985, 1989, 1993, 1997, 2001, 2005

Total Biomass (Kg/ha)
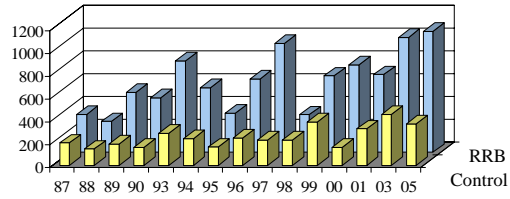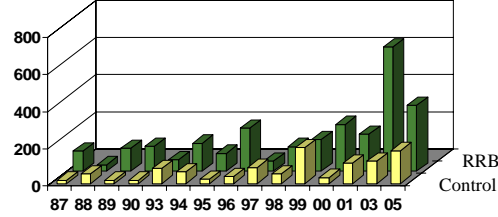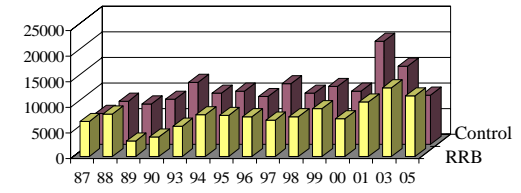
Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)
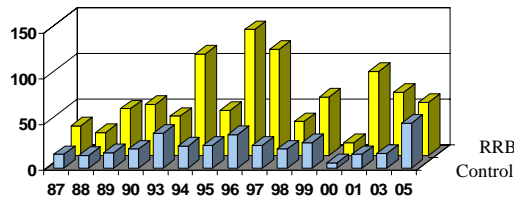
Sedge, Panicum, and Grass Biomass (Kg/ha)
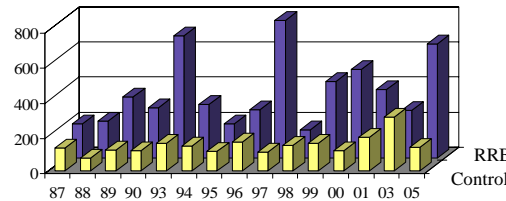
Pine Diameter Distribution, 2001
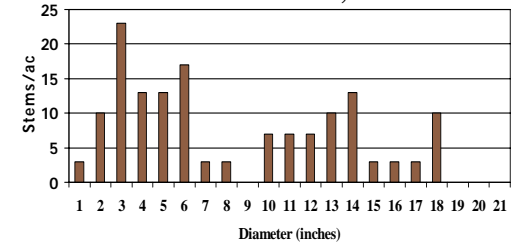
Woody Stem Density, Fall 2004
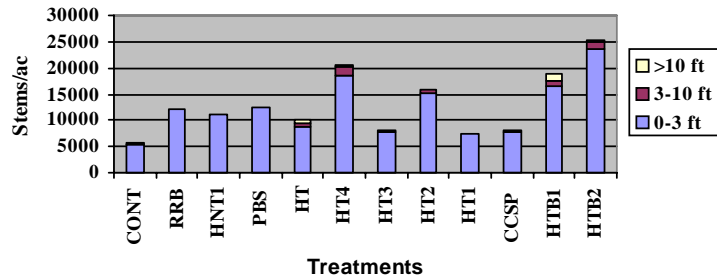
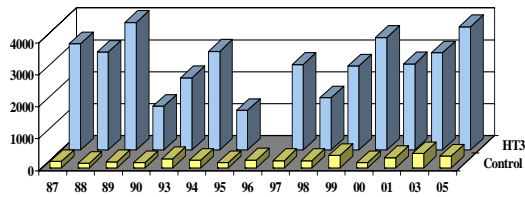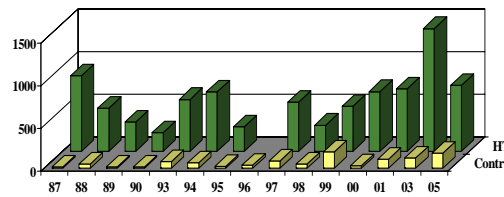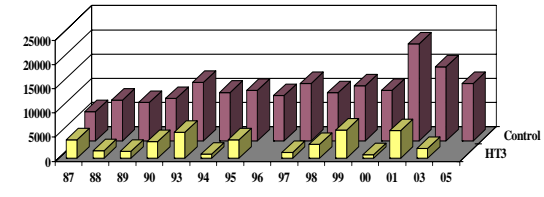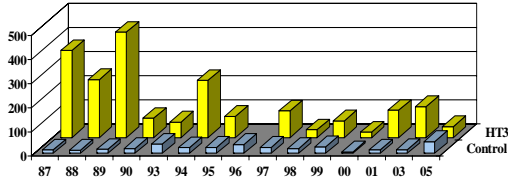### Basal Area Change 1983-2005
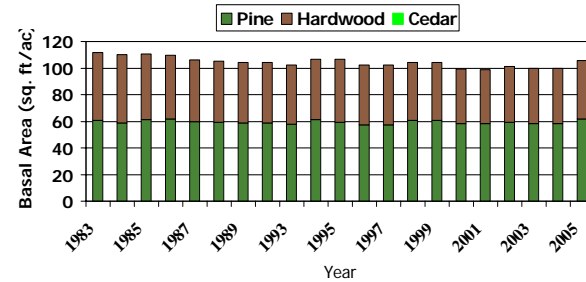
HT (Harvest, Thin, No Burn)

HT

Harvest pine timber & thin ½ BA of hardwood, 1984

Total Biomass (Kg/ha)
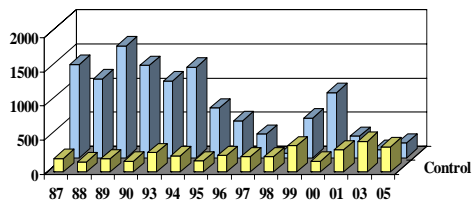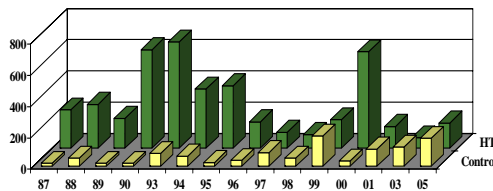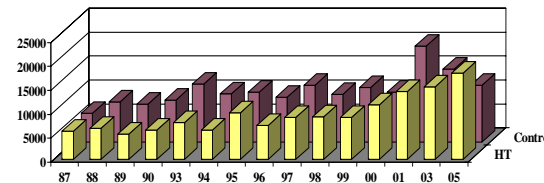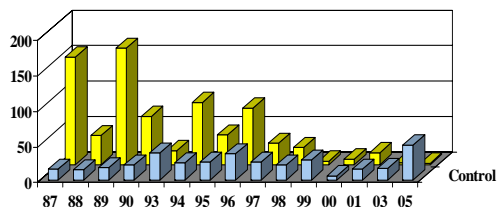
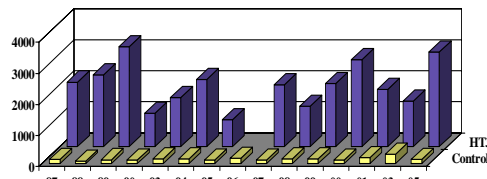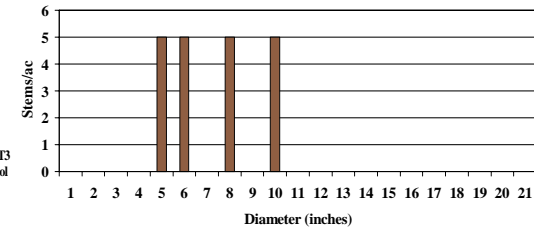## Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

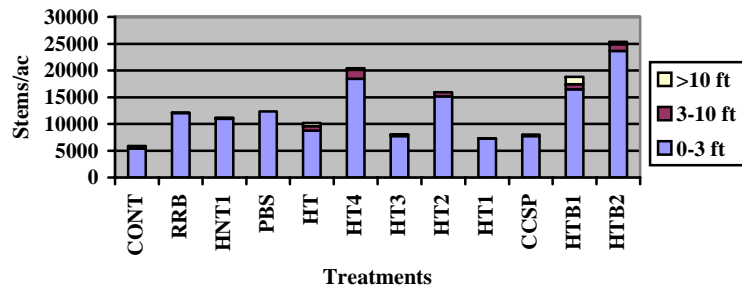
Forb and Legume Biomass (Kg/ha)

Sedge, Panicum, and Grass Biomass (Kg/ha)
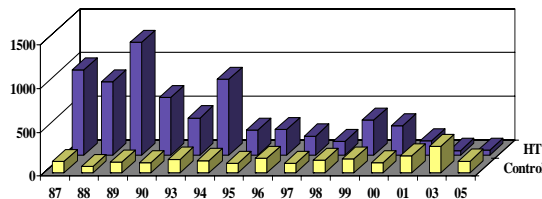
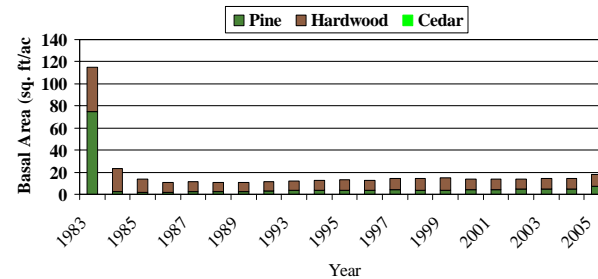## Pine Diameter Distribution, 2001
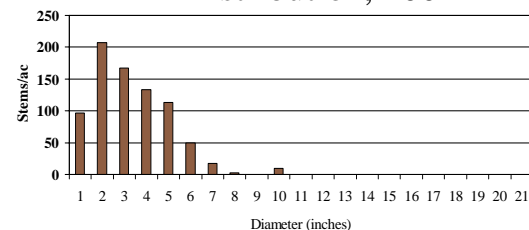
Woody Stem Density, Fall 2004
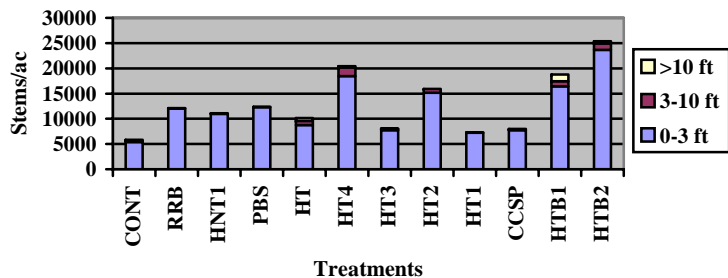
Basal Area Change 1983-2005
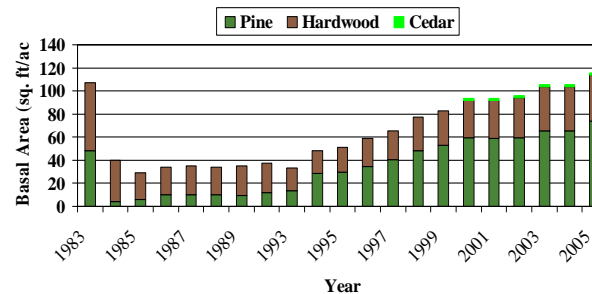
HT (Harvest, Thin, Burn 1 time, 1989)

HT, 1 burn

Harvest pine timber & thin ½ BA of hardwood, 1984

Burned late winter 1989, 2002

Total Biomass (Kg/ha)
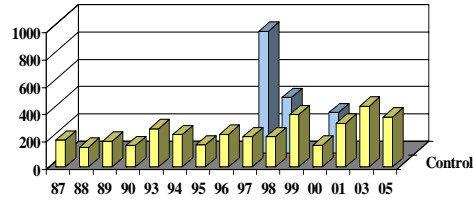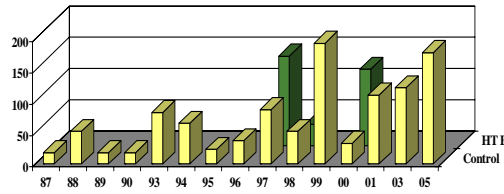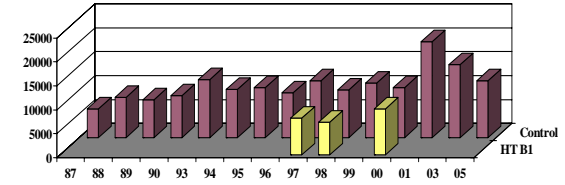
Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)
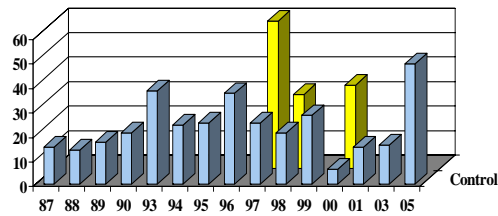
Sedge, Panicum, and Grass Biomass (Kg/ha)
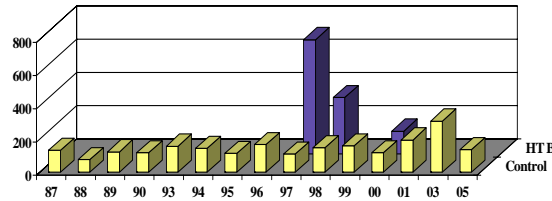
Pine Diameter Distribution, 2001
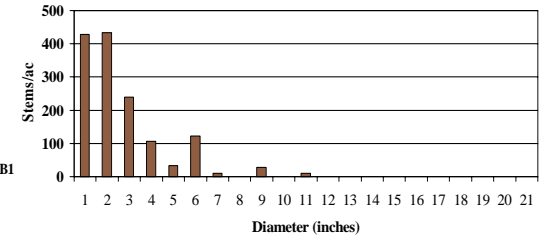
Woody Stem Density, Fall 2004
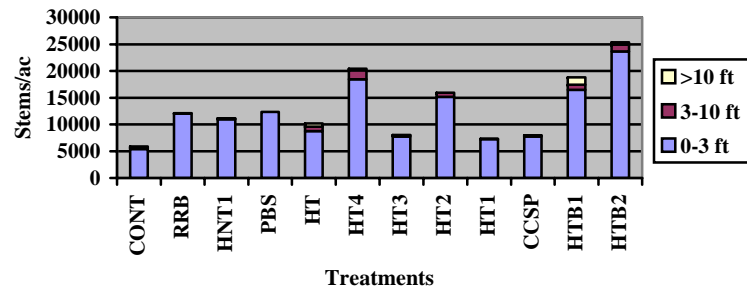
Basal Area Change 1983-2005
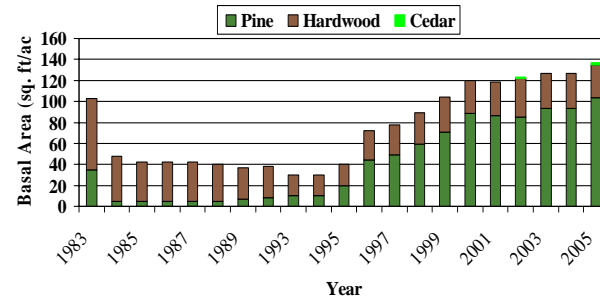
HT (Harvest, Thin, Burn 2 times, 1989, 1996)

HT, 2 burns

Harvest pine timber & thin ½ BA of hardwood, 1984

Burned late winter 1989, 1996, 2002

Total Biomass (Kg/ha)
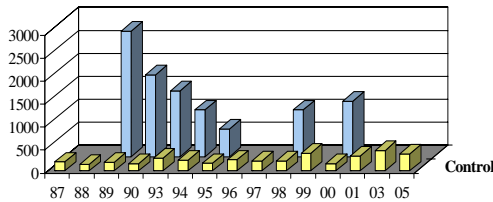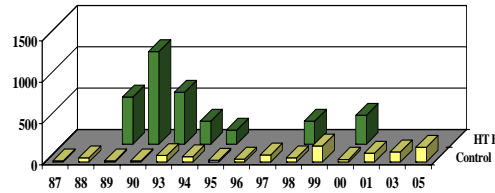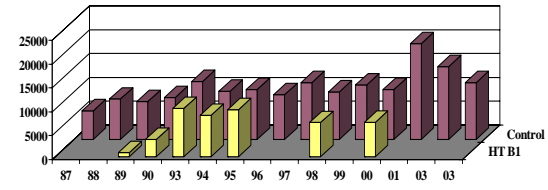
Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)
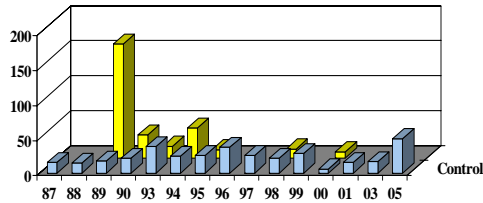
Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004
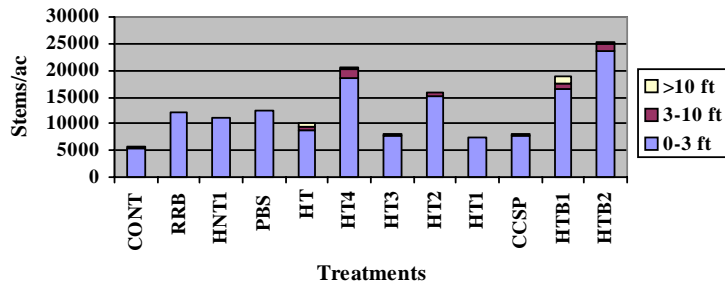
Basal Area Change 1983-2005
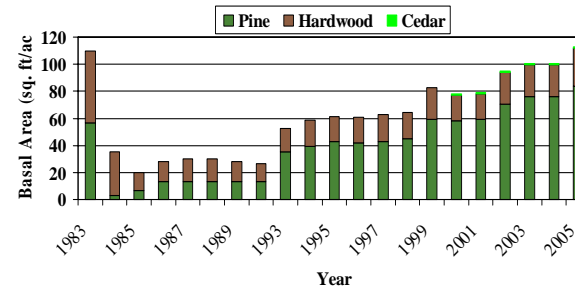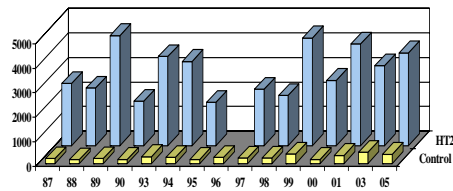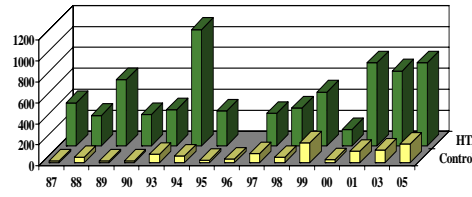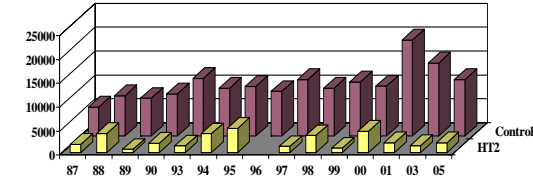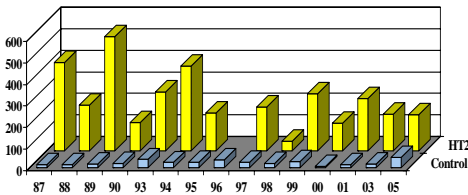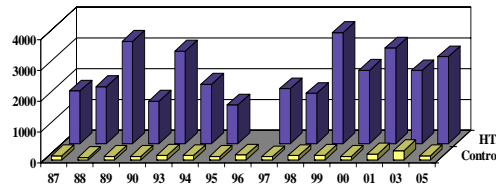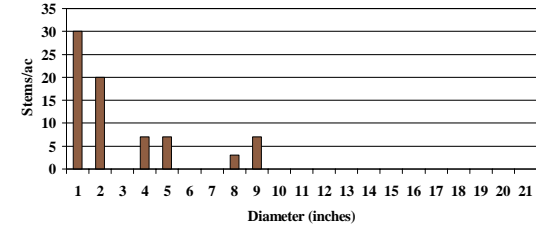
HT4 (Harvest, Thin, 4-year Burn Interval)

HT4

Harvest pine timber & thin ½ BA of hardwood, 1984

Burned late winter 1985, 1989, 1993, 1997, 2005

Total Biomass (Kg/ha)
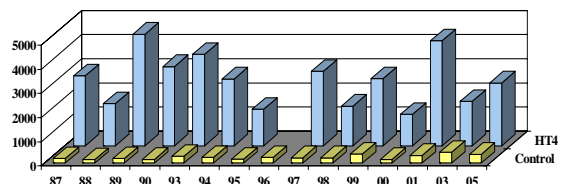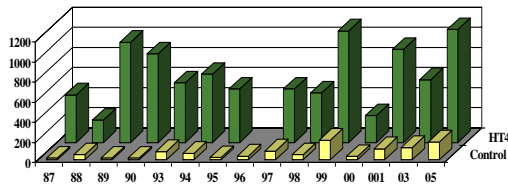
Woody Biomass (Kg/ha)

Litter Biomass

Forb and Legume Biomass (Kg/ha)
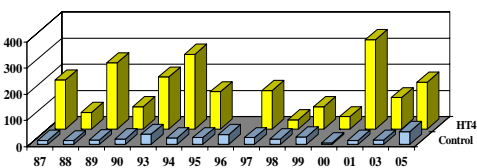
Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004
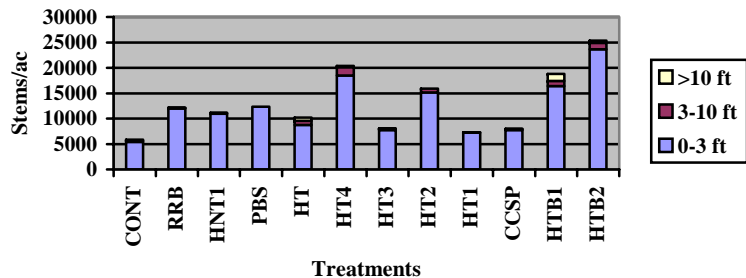
Basal Area Change 1983-2005
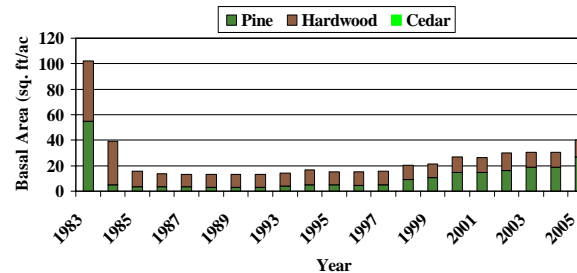
HT3 (Harvest, Thin, 3-year Burn Interval)

HT3

Harvest pine timber & thin ½ BA of hardwood, 1984

Burned late winter 1985, 1988, 1991, 1994, 1997, 2000, 2003

Total Biomass (Kg/ha)

Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

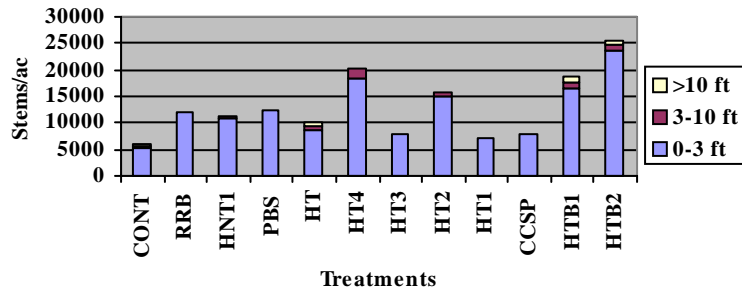Forb and Legume Biomass (Kg/ha)

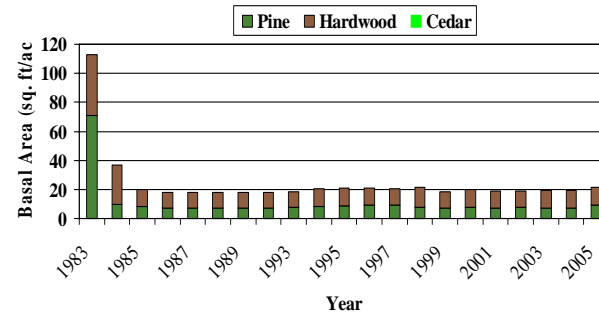Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004

Basal Area Change 1983-2005

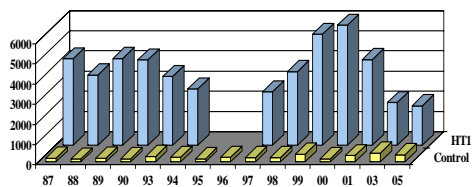# HT2 (Harvest, Thin, 2-year Burn Interval)

HT2

Harvest pine timber & thin ½ BA of hardwood, 1984

Burned late winter 1985, 1987, 1989, 1991, 1993, 1996, 1997, 1999, 2001, 2003, 2005

Total Biomass (Kg/ha)

Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)

Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004

Basal Area Change 1983-2005

HT1 (Harvest, Thin, 1-year Burn Interval)

HT1

Harvest pine timber & thin ½ BA of hardwood, 1984

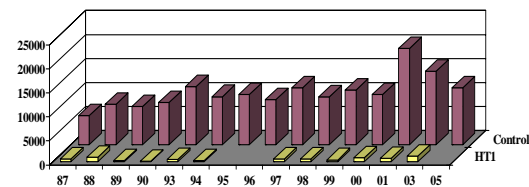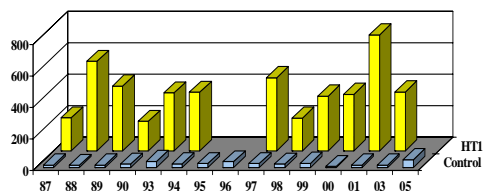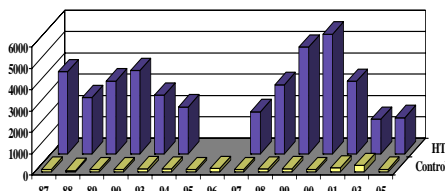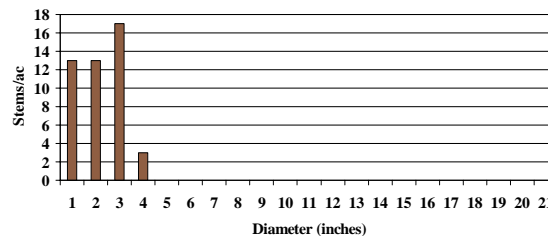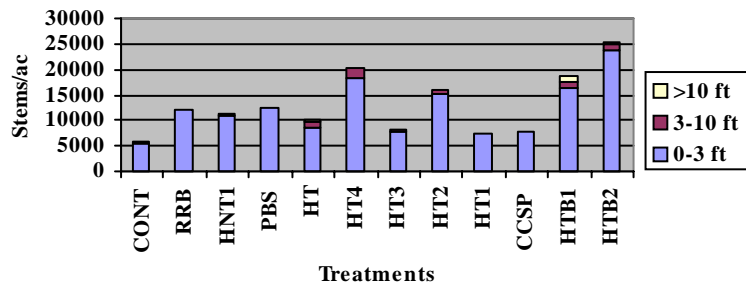Burned late winter annually except 1995

Total Biomass (Kg/ha)
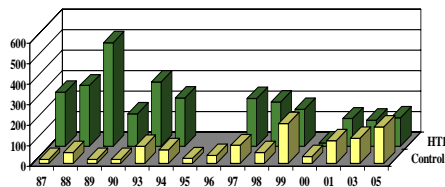
Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)

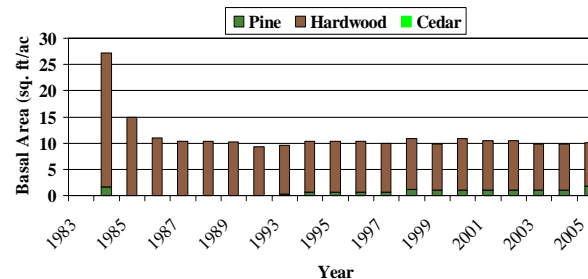### Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004

Basal Area Change 1983-2005

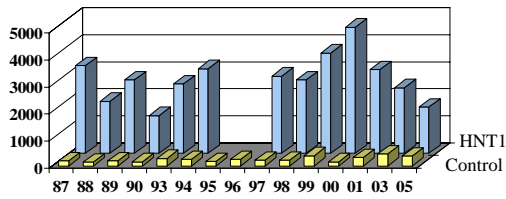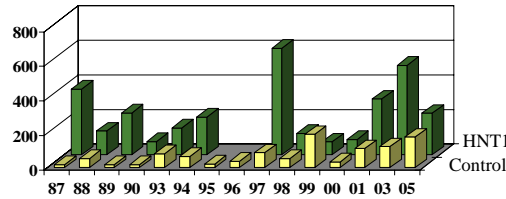# HNT1 (Harvest, No-thinning, 1-year Burn Interval)

HNT1

Harvest pine timber 1984, no thinning of hardwood

Burned late winter annually except 1995

Total Biomass (Kg/ha)
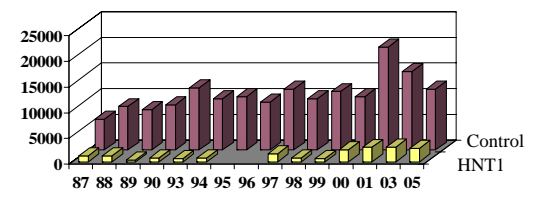
Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)

Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004

Basal Area Change 1983-2005
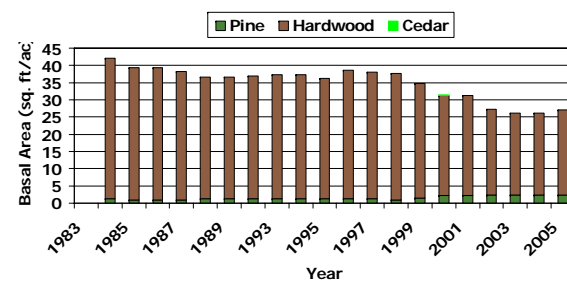
CCSP (Clear cut, summer site preparation burn)

CCSP

Clear cut,
Summer site prep burn
Plant loblolly pine, April

Winter burn 1996
Salvage thin 2001
Winter burn
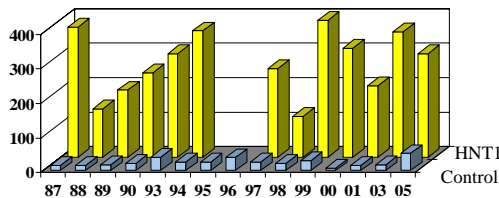
Total Biomass (Kg/ha)
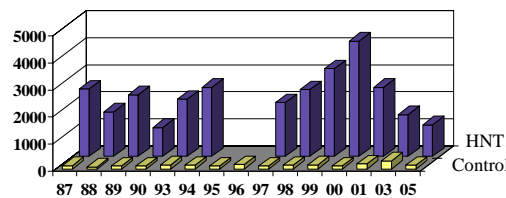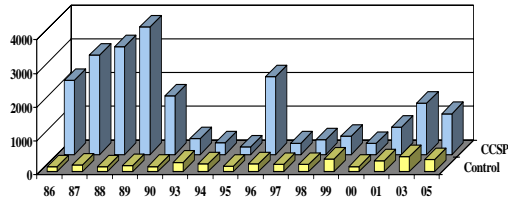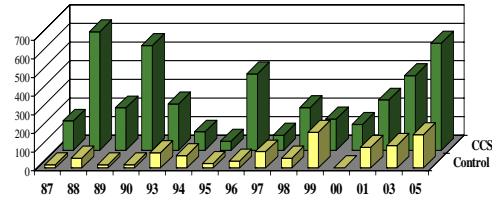

Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)

Forb and Legume Biomass (Kg/ha)

Sedge, Panicum, and Grass Biomass (Kg/ha)

Pine Diameter Distribution, 2001

Woody Stem Density, Fall 2004

Basal Area Change 1983-2005
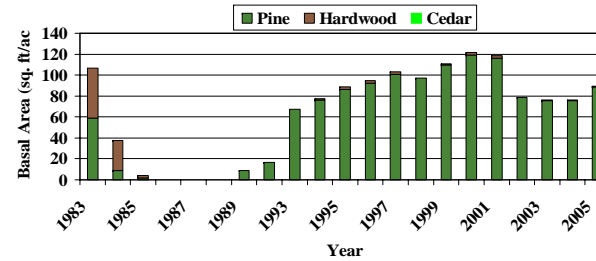
PBS (Thin hardwood, 1-year Burn Interval, Salvage in 1998)

PBS

Burned late winter annually except 1995
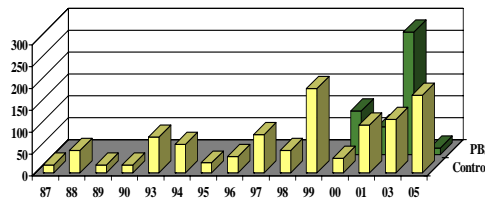
Total Biomass (Kg/ha)

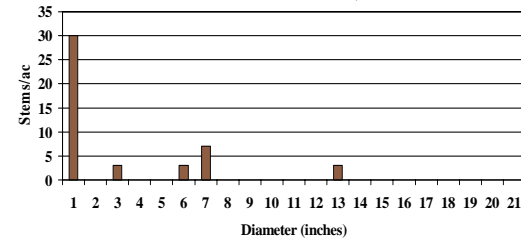## Woody Biomass (Kg/ha)

Litter Biomass (Kg/ha)
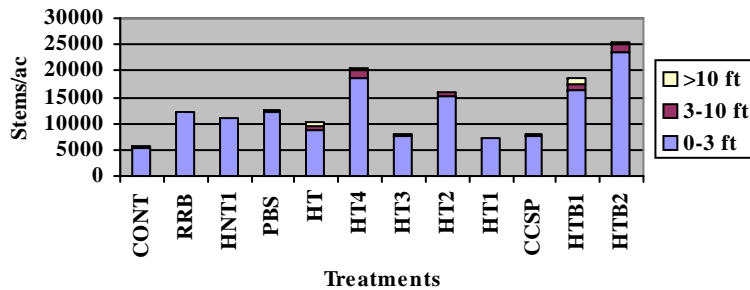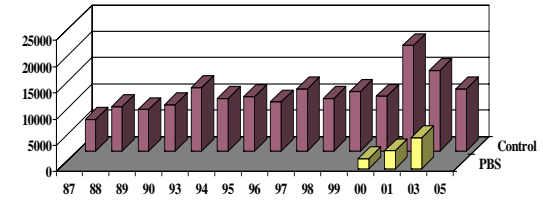

Forb and Legume Biomass (Kg/ha)
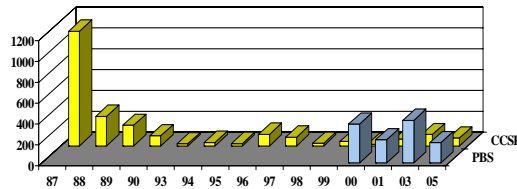
Sedge, Panicum, and Grass Biomass (Kg/ha)
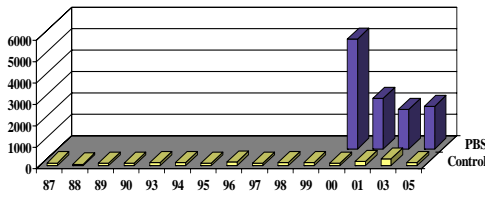
Pine Diameter Distribution, 2001
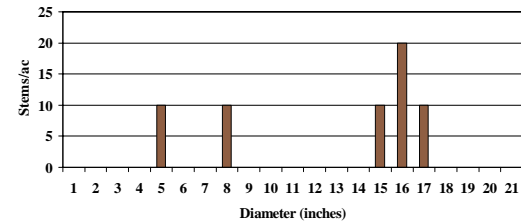
Woody Stem Density, Fall 2004
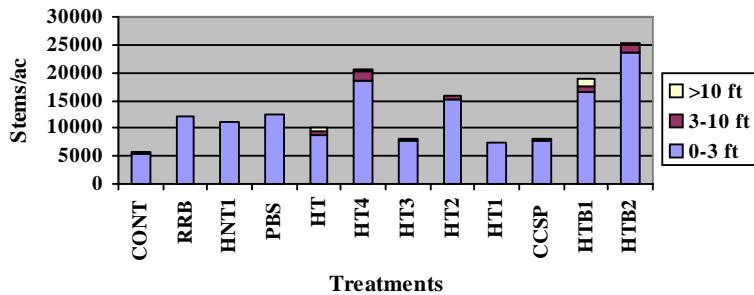
Basal Area Change 1983-2005

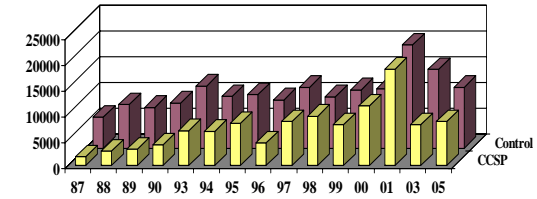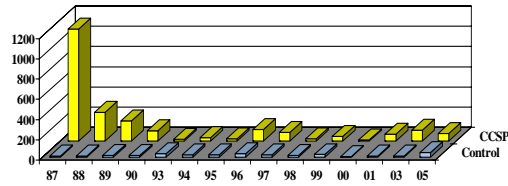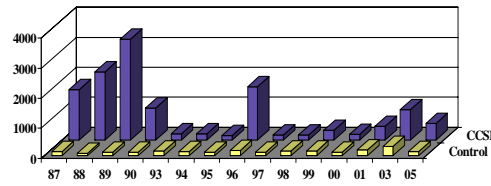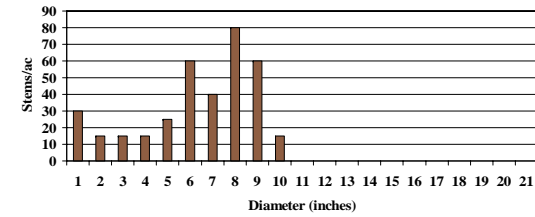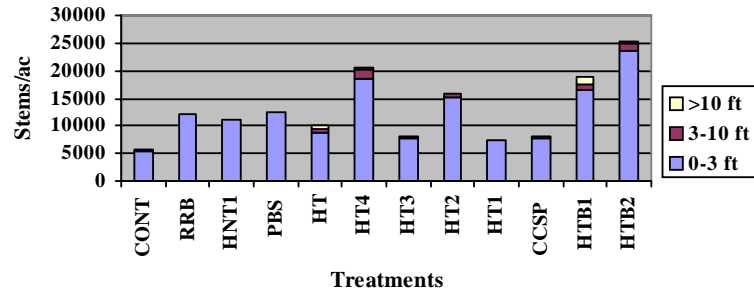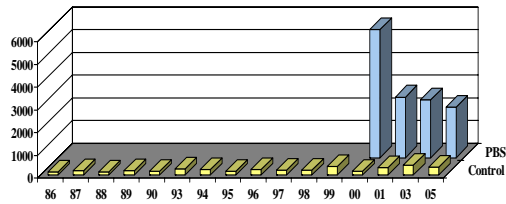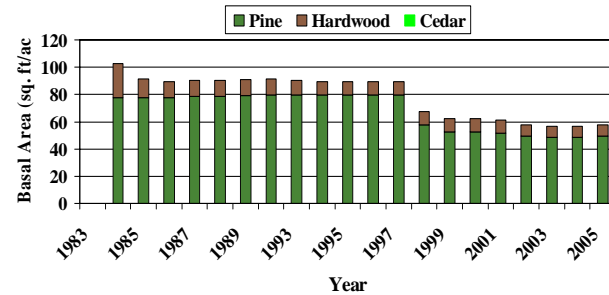# Grazing Management for Beef Cattle on Forestland in Eastern Oklahoma

INTRODUCTION

The lack of proper grazing management is the number one limiting factor facing cattle producers in eastern Oklahoma. Most soils in eastern Oklahoma produce woody plants that compete with herbaceous vegetation, cattle, and some wildlife species. Cattle producers must learn how to set stocking rates that allow for enough herbaceous fuel to support a fire that will control woody plants. However, this seldom occurs and many sites are grazed to the point that hay is fed for 4-6 months and no herbaceous plants are available for cattle or as a fuel source for fire. Thus most of eastern Oklahoma is covered with historically un-natural amounts of brush and the land is in poor condition. Although grazing efficiency is normally set at 25%, grazing systems should begin with a light stocking rate until native plant communities have been restored to their potential. Many research studies have shown that light (12.5%) to moderate (25%) stocking rates produce maximum net profits and are optimum for long-term stability. See OSU Fact Sheet No. 2871, Stocking Rate: The Key to Successful Livestock Production, and Circular E-926, Grazing Management on Rangeland for Beef Production for more detailed information.

Herbaceous Standing Crop on PFHRA (6-year ave.)
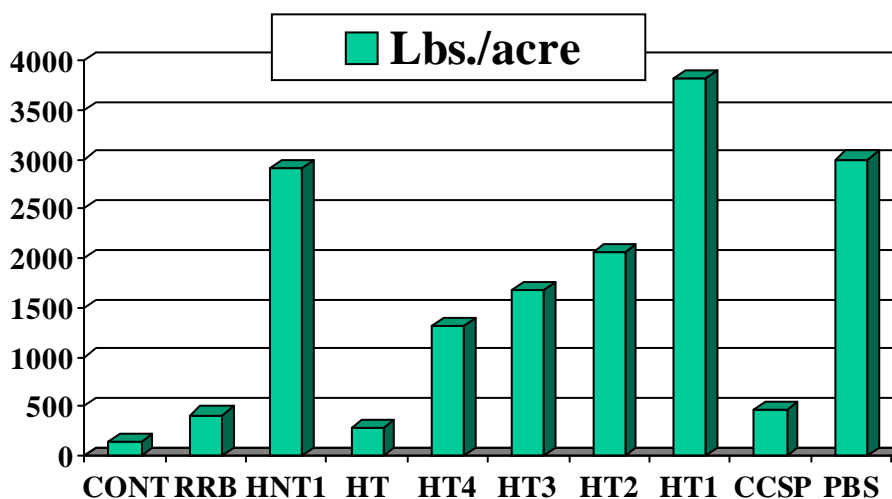
COMMON GRAZING SYSTEMS

Alternative 1: Cow-Calf Year Round Grazing

When calculating livestock carrying capacity for cows (1,000 lbs. dry), we assume the forage intake is 26 lbs. per day, 780 lbs. per month, or 9,360 lbs. per year. Take end-of-season standing crop and multiply by grazing efficiency. Under continuous grazing with cows (AUE=1.0) (AUE-animal unit equivalent) on native grass use no more than 25% of the end-of-season standing crop. Bulls and replacement heifers are not calculated in this example. Acres per cow increase when bulls and replacement heifers are figured.

For example, in the column under control (the comparison or check plot where no treatments have been made), take 142 lbs. times 25% = 35.5 lbs. per acre available for grazing. The forage demand for a dry cow is 26 lbs. per day. Divide 35.5 lbs. per acre by 26 lbs. per day = 1.37 AUD (animal unit days) per acre. Thus, the maximum each acre could support would be 1 cow for 1.37 days. For a year, divide 365 days by 1.37 days per acre = 267 acres. The carrying capacity for one cow is 267 acres for the control site (no treatment).

For another example, the HT1 treatment, take 3,826 lbs. times 25% = 956.5 lbs. per acre available for grazing. The forage demand for a dry cow is (1 animal unit equivalent) 26 lbs. per day. Divide 956.5 lbs. per acre by 26 lbs. per day = 36.79 ADU (animal unit days) per acre. Thus, the maximum each acre could support would be 1 cow for 36.79 days. For a year, divide 365 days by 36.79 days per acre = 10 acres. The carrying capacity for one cow is 10 acres on the HT1 (harvest, thin, annual burn).

Remember that these stocking rates do not include bulls, replacement heifers, or retained calves. The forage demand for this situation would be (1.25 animal unit equivalents) 1.25 times 26 lbs. per day = 32.5 lbs. per day. A detailed stock flow chart is the best solution but 32.5 lbs. per day will fit many beef cattle operations.

	Control	RRB	HNT1	HT	HT4	HT3	HT2	HT1	CCSP	PBS
Standing Crop	142	414	2,913	278	1,313	1,670	2,056	3,826	462	3000
25% Efficiency - Available for grazing.	35.5	103.5	728.3	69.5	328.3	417.5	514	956.5	115.5	750
AUD/Acre	1.37	3.98	28.01	2.67	12.63	16.06	19.77	36.79	4.44	28.85
Acres/Cow	267	92	13	137	29	23	18	10	82	13

Stocking Rate for a Cow-Calf Operation on Forestland in Eastern Oklahoma
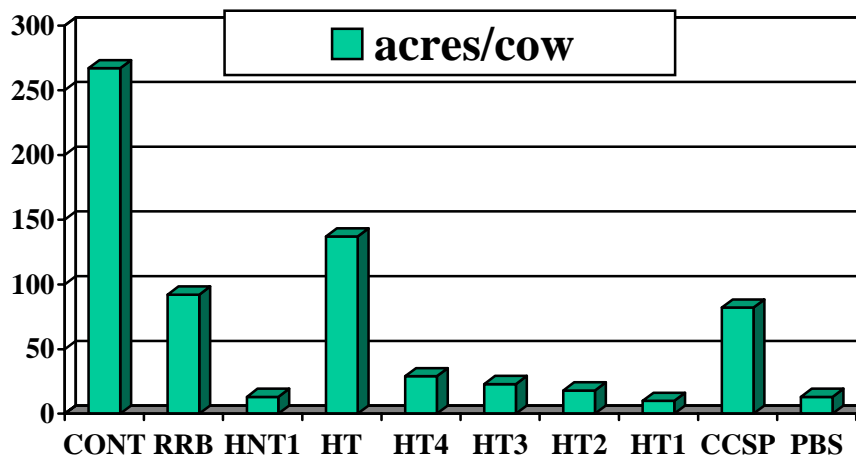
Alternative 2: Stocker Cattle for 5 months (150 days)

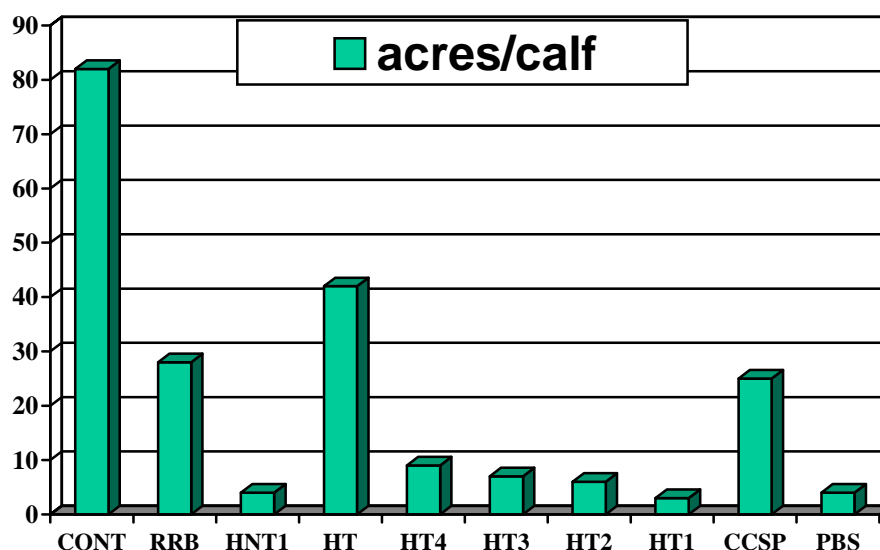For season long stocking (SLS), use the end-of-season standing crop to calculate the animal unit equivalent (AUE) for average weight calf over 5 months (150 days). For example, average the weight in (500 lbs.) and the weight out (800 lbs.). The average weight is 650 lbs. (0.65 AUE plus 0.1 = 0.75). The AUE would equal 0.75 (75% of a 1,000 lb. dry cow) so the intake per day would be (0.75 times 26 lbs.) or 19.5 lbs. per day. Divide 35.5 lbs. per acre available for grazing (from the control site) by 19.5 lbs. per day = 1.82 AUD (animal unit days) per acre. Thus, the maximum each acre on the control site could support would be 1 calf for 1.82 days. For 150 days, divide 150 days by 1.82 days per acre = 82 acres per calf for 150 days.

In the most productive treatment (HT1), we would divide 956.5 lbs. per acre by 19.5 lbs. per day = 49.05 AUD (animal unit days) per acre. Thus the maximum each acre on the HT1 treatment could support would be 1 calf for 49 days. For 150 days, divide 150 days by 49.05 days per acre = 3 acres per calf for 150 days.

	Control	RRB	HNT1	HT	HT4	HT3	HT2	HT1	CCSP	PBS
Standing Crop	142	414	2,913	278	1,313	1,670	2,056	3,826	462	3000
25% Efficiency - Available for grazing.	35.5	103.5	728.3	69.5	328.3	417.5	514	956.5	115.5	750
Acres/Calf – 150 days	82	28	4	42	9	7	6	3	25	4

Stocking Rate for Calves for 5 months on Forestland in Eastern Oklahoma

Alternative 3: Stocker Cattle for 2.5 months (75 days) - Intensive Early Stocking (IES)

For Intensive Early Stocking (IES) (see Fact Sheet No. 2875) you can run twice (2X) the number of stocker cattle (calves) that we used in Alternative 2 for one-half the amount of time. Thus the stocking rate has not changed.

Take the end-of-season standing crop and calculate the animal unit equivalent (AUE) for average weight calf over 2.5 months (75 days). For example, average the calf weight in (500 lbs.) and the weight out (650 lbs.). The average weight is 575 lbs. (0.575 plus 0.1 = 0.675) The AUE would equal 0.675 (67.5% of a 1,000 lb. dry cow) so the intake per day would be (0.675 times 26 lbs.) or 17.55 lbs. per day. Divide 35.5 lbs. per acre available for grazing (from the control site) by 17.55 lbs. per day = 2.02 AUD (animal unit days) per acre. Thus, the maximum each acre on the control site could support would be 1 calf for 2.02 days. For 75 days, divide 75 days by 2.02 days per acre = 37.13 acres per calf for 75 days.

In the most productive treatment (HT1), we would divide 956.5 lbs. per acre by 17.55 lbs. per day = 54.5 AUD (animal unit days) per acre. Thus the maximum each acre on the HT1 treatment could support would be 1 calf for 54 days. For 75 days, divide 75 days by 54.5 days per acre = 1.38 acres per calf for 75 days.

	Control	RRB	HNT1	HT	HT4	HT3	HT2	HT1	CCSP	PBS
Standing Crop	142	414	2,913	278	1,313	1,670	2,056	3,826	462	3000
25% Efficiency - Available for grazing.	35.5	103.5	728.3	69.5	328.3	417.5	514	956.5	115.5	750
Acres/Calf - 75 days (IES)	37	13	2	19	4	3	3	1	11	2

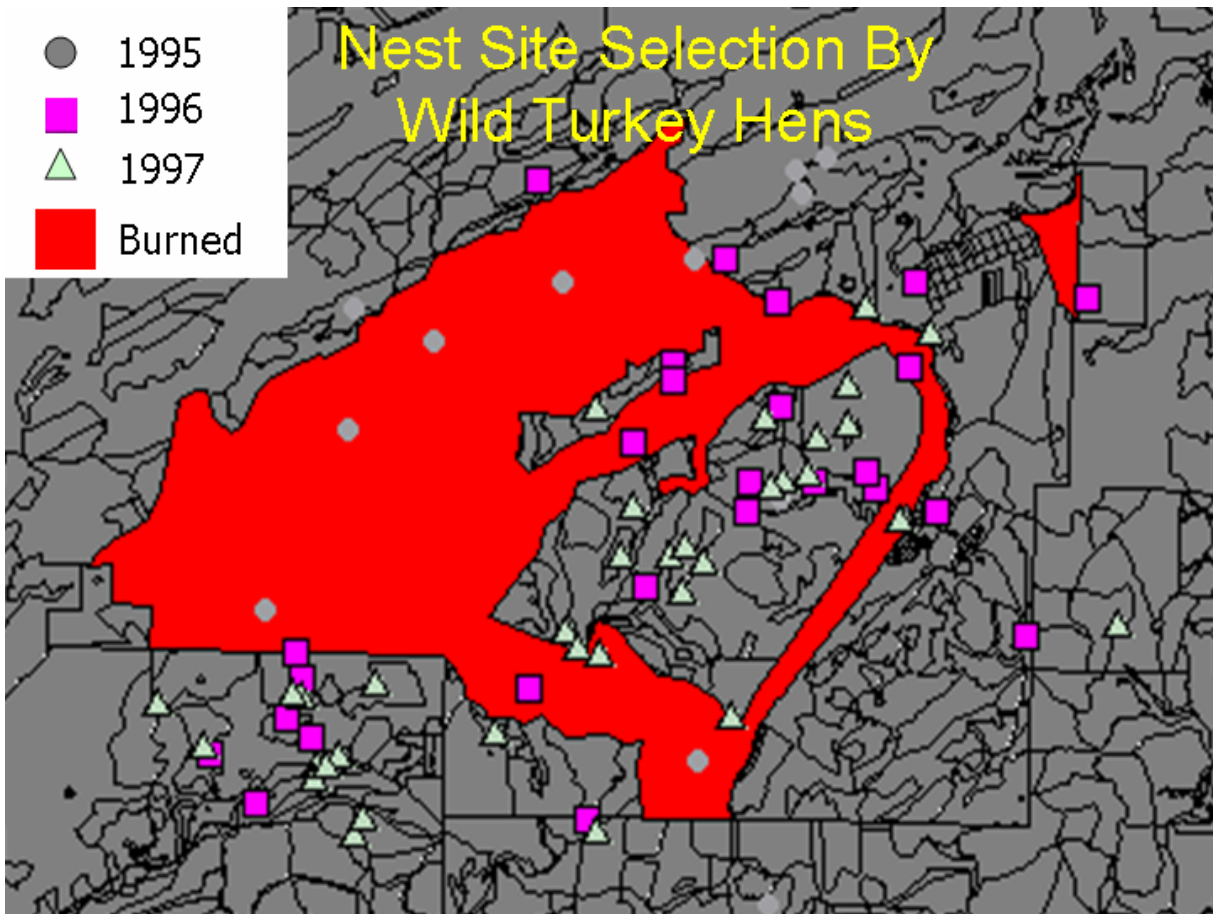**Stocking Rate for Calves for 2.5 Months on Forestland in Eastern Oklahoma**
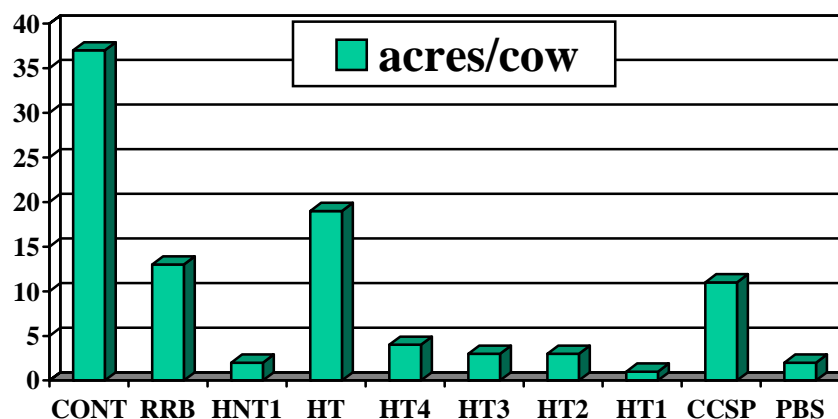
Figure 10. Nesting locations from 1995-1997 in relation to a winter 1997 fire on Pushmataha Wildlife Management Area. Circles are 1995 nest locations, squares are 1996 nest locations and triangles are 1997 nesting locations.
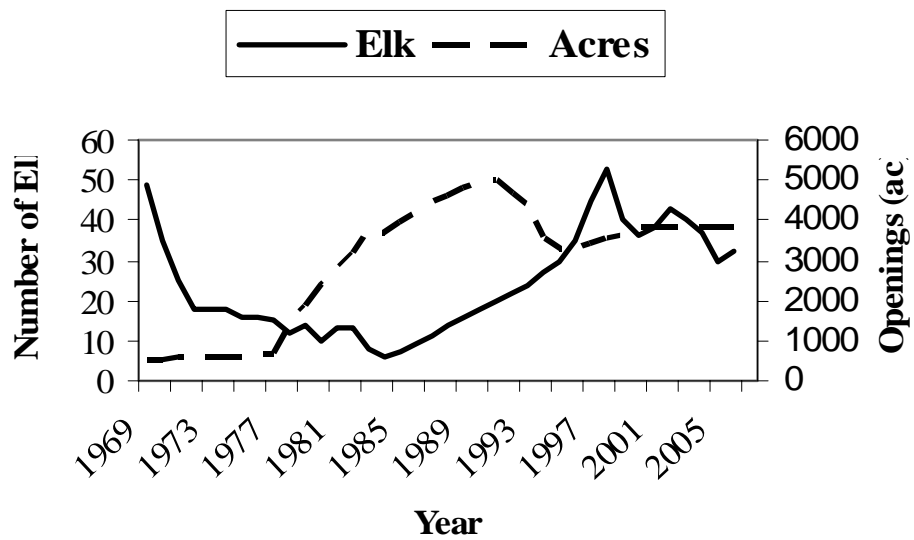
Elk Response to Openings

Figure 11. Elk population response on Pushmataha WMA from 1969-2005.

Pushmataha Forest Habitat Research Area

Headquarters

N

Pine Tree Circle

FP

FP

| 18 HT4 | 25 HT | 19 HNT1 | | 20 HT1 | 26 HT | 28 HT | 27 PBS | 21 HT1 | 22 HNT1 | 23 HNT1 | 24 HT1 | | |

| 17 HT2 | 14 RRB | Pond | 11 HT4 | 9 HT3 | 8 HT2 | 7 CCSP | 6 HT3 | 5 CONT | 3 RRB |

| 16 RRB | 13 HTB1 / 33 HTB2 | 12 CCSP | 10 CONT | | | | | 4 HT2 | 2 CCSP |

| 15 HT4 | | | | FP | | FP | 1 CONT |

FP

Pine Tree Circle

Pine Tree Circle