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ESTHETICS EVALUATION

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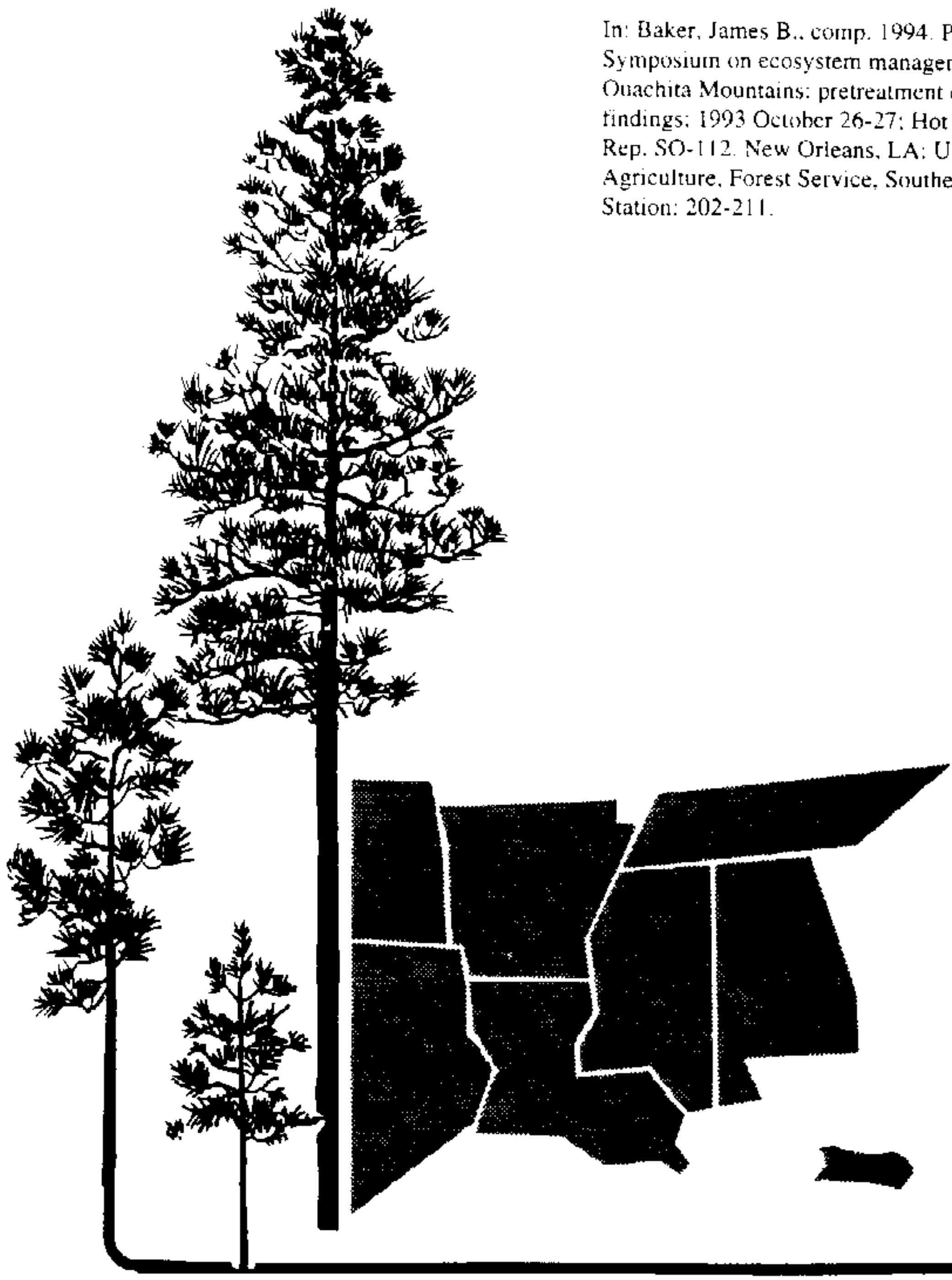

Southern Forest Experiment Station

1994

Esthetics Evaluation[1]

Victor A. Rudis, James H. Gramann, and Theresa A. Herrick[2]

ABSTRACT

An analysis of summer visual attributes and an overview of ongoing scenic quality research within selected shortleaf pine (*Pinus echinata* Mill.)-hardwood stands in the Ouachita and Ozark National forests are presented. Within-stand visual attributes were reported prior to even-aged stand-level (Phase II) treatment for twelve 40-acre stands in the north, east, and south regions and for plot-level (pre-Phase I) visual attributes for twenty 0.5-acre plots examined two growing seasons after disturbance. No differences in visual attributes before treatment were apparent between 0.0 to 2.8 feet and 2.9 to 5.5 feet aboveground. From the stand-level study, there were no significant differences among regions but there were significant differences among stands and sample points. The plot-level study, a randomized complete block design with four blocks or landform positions and uneven-aged treatments, revealed differences by distance zone aboveground for disturbed plots. Greater foliage and twig screening and reduced visual penetration in lower zone views were associated with increased overstory removal. Visual penetration was lower and foliage and twig screening was higher in low elevation landform positions compared with high elevation landform positions. Insight from both studies suggests that a significant difference between viewing zones in summer may be suitable as an index of recent stand disturbance.

INTRODUCTION AND OVERVIEW

Public agencies and private owners are increasingly confronted with public reaction to timber harvest and reproduction cutting activities. One frequent issue revolves around the loss of esthetics caused by disturbances. Maintaining and enhancing the visual quality of forests are also becoming more important as competing uses for forest land intensify, particularly on public forest land.

Methods to measure esthetics have been successful in quantifying public perception of a forest's scenic beauty (Ribe 1989, Rudis and others 1988). Stands with limited screening and limited downed woody material and a moderate amount of sawtimber-sized trees are rated higher on a scenic beauty rating scale than those with extensive screening, small-diameter trees, or large amounts of downed woody material.

Many scenic quality studies have suggested silvicultural treatments that alter esthetics, but few have directly tested the effect of alternative treatments. Few studies have examined treatments over an extended time span, and none are specific to mixed pine (*Pinus* spp. L.) and oak (*Quercus* spp. L.) stands typical of the Ouachita Mountains. Examination of esthetics before and after treatments are applied can address tradeoffs among alternative silvicultural practices.

Esthetics is defined as an emotional response to an object. This emotional response can be divided into three measurement categories: the attributes of the object, the viewer, and intervening conditions between the viewer and the object. Esthetics is commonly quantified by viewers as scenic beauty ratings and standardized with techniques developed by Daniel and Boster (1976).

The majority of this report focuses on within-stand visual attributes for shortleaf pine (*Pinus echinata* Mill.)-hardwood stands on the Ouachita and Ozark National Forests (NF) (Baker 1994). Other works in progress address a viewer's

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background, a viewer's perception of scenic beauty, and some of the intervening conditions. These are being investigated in studies by cooperators at Arkansas Tech University, Texas A&M University, and Mississippi State University.

Arkansas Tech's role, directed by Theresa Herrick, focuses on the viewer (Rudis and others 1991). Herrick reports on a recreation user survey of scenic preferences in the Ouachita NF (Herrick and Rudis 1994). Work has also begun on stand-level (Phase II), within-stand scenic beauty estimation of pretreatment conditions prior to even-aged treatment. A postharvest assessment of seasonal differences in scenic beauty is planned.

Texas A&M University's role, directed by Jim Gramann, focuses on the object as perceived by viewers and some of the varying conditions (Rudis and Gramann 1990). Jim Gramann reports on progress in characterizing within-stand scenic beauty by season, landform, and treatment (Gramann and Rudis 1994). Uneven-aged timber management is examined for 0.5-acre plots in the Winona Ranger District near Lake Sylvia (Winona plots). Although not reported in this proceedings, Gramann and colleagues at Texas A&M have digitized photographs to examine color differences by season (Rudis and others 1991). Color, texture, and shadow effects are likely important in determining scenic beauty from distant views or vistas, an important component of landscape-scale (Phase III) ecosystem management research.

Mississippi State's role, directed by Dennis Cengel and Rebecca Ray, has just begun (Rudis and others 1993). Ray has taken posttreatment "intermediate" views of all 39 north, east, and south Phase II stands. Intermediate views are those typically seen from a roadside or from stand boundaries. The views encompass 3 control stands and 36 treated stands. Because views have just been photographed (October 1993), no results are reported in this proceedings. Specific objectives of this study include determining what constitutes the most visually acceptable harvests. Different groups of viewers will make assessments of scenic beauty and willingness-to-pay for altered treatments. A subset of views will be prepared as photographs and shown to loggers to estimate perceived costs. These estimates will be compared with actual cost information gathered by Kluender and others (1994).

Evaluating Within-Stand Visual Attributes

The proportion of each view within stands was sampled along a 30 degree arc outward to 50 feet (ft). Visual attributes were divided into visual penetration, foliage and twig screening, tree-bole screening, and nonvegetative screening. **Tree-bole screening** is defined as the occupancy of tree trunks at least 5 inches in diameter at breast height (d.b.h.); i.e., at 4.5 ft. **Foliage and twig screening** is vegetative screening by tree trunks less than 5 inches d.b.h. and all foliage and twigs. **Nonvegetative screening** includes rocks, bare soil, and litter. **Visual penetration** is the absence of the other three components, i.e., the "unscreened" portion of the view. Limited screening by foliage and twigs, abundant visual penetration, and a high density of tree-bole screening is correlated with high scenic beauty ratings in loblolly-shortleaf pine stands (Rudis and others 1988). The relationship of visual attributes to scenic beauty ratings is also interpretable in psychological terms (Ruddell and others 1989).

A scaling device called a screenometer was used to estimate the proportion of visual attributes. The screenometer was modified from that described in Rudis (1985) to include 9 instead of 10 horizontal segments, and two height zones instead of one. Nine horizontal segments per zone view were used to ease record keeping. Two zone views, a lower zone approximating 0.0 to 2.8 ft, and an upper zone approximating 2.9 to 5.5 ft above the ground, were etched onto the viewpiece to increase its resolution for detecting small-scale changes and compare its utility for foliage height-dependent wildlife habitat assessments.

Analysis of variance, means, and standard errors were calculated from arcsine square root transformation of proportions. Calculations, analysis of variance, F-tests, and standard errors used the general linear model (GLM) procedure (SAS Institute Inc. 1990). Means and standard errors were transformed back into proportions for display purposes. For Winona plots, planned comparisons between means associated with significant sources of variation ($P[F] < 0.05$) were conducted using t-tests and the least-squares means option (SAS Institute Inc. 1990).

Phase II Stands

Methods.--Pretreatment conditions for stands to be treated were examined in June 1992. Planned treatments included clearcut, shelterwood, group selection, and control in north, east, and south regions for a total of 16 stands (table 1). Screening estimates for each stand were based on 30 observations taken in June 1992. Observations comprised 15 sectors and 2 zone views per sector. Screening sectors were centered at 30 degree intervals beginning with azimuth 30 degrees. Sectors were viewed from the center of points coincident with the center of bird census plots (Petit and others 1994). One screenometer sector was assigned at random to each point; the second sector was 180 degrees in the opposite direction. In four stands with five points, a third sector was assigned at random. In eight stands with six points, the third sector was assigned to points 2, 4, and 6.

Table 1.-- *Region, planned treatment, and national forest compartment and stand number examined for within-stand visual attributes, Ouachita and Ozark National Forests of Arkansas*

Region*	Planned treatment	Compartment	Stand
North (Arkansas River Valley ecoregion)	Clearcut	458	16
	Shelterwood	457	12
	Group selection	46	18
	Control, no treatment	284	11
East (upper Ouachita Mountain ecoregion)	Clearcut	1067	15
	Shelterwood	1119	21
	Group selection	1124	11
	Control, no treatment	605	5
South (lower Ouachita Mountain ecoregion)	Clearcut	1658	5
	Shelterwood	27	1
	Group selection	35	42
	Control, no treatment	23	10

* See Baker (1994)

Points were systematically located across the portion of stands to be treated. Because of bird census requirements, points had to be at least 426 ft (130 m) apart and at least 295 ft (90 m) from stand boundaries. Potential stream management zones (SMZ's) were retained untreated within several stand boundaries. Points were moved away from potential SMZ's when obvious from field observations and topographic maps. Due to these restrictions and the variable shape of stands, there were five points in four stands and six points in eight stands. Photographs were taken along the same azimuths and points used to estimate screening. Scenic beauty beauty ratings, at present incomplete, will follow procedures noted elsewhere (Gramann and Rudis 1994).

Results.--Components of the analysis of variance are contained in tables 2 and 3. Table 3 lists the analysis of variance for nonvegetative screening by lower zone views, as there was no nonvegetative screening in the upper zone. An F-test failed to reject the null hypothesis that regional differences existed (P[F] = 0.08) (table 2). Analysis of variance tests revealed no significant differences by zone (P[F] $\geq$0.22). Differences by point were significant. Tests revealed significant differences among points within stands for all screening categories (P[F] <0.01). Differences in variance among stands were not significant (P[F] $\geq$0.19) for tree-bole screening but were significant (P[F]<0.05) for foliage and twig screening and visual penetration. Variance attributed to the two distance zones was not significant.

Table 2.--*Analysis of variance for summer 1992 visual attributes by screenometer category, Phase II stands*

		Mean square variance by category		
Source	Degrees of freedom	Tree boles	Foliage and twigs	Visual penetration
Region	2	2,057.2	2,551.4	676.8
Stand*region	9	728.5	2,713.6†	1,487.1†
Point*stand*region	56	485.3†	1,074.7‡	606.7‡
Pooled mean square combined from below: (P[F] $\geq$0.22. Denominator is residual mean square)	292	149.2	219.7	182.7
Zone	1	28.8	0.3	5.1
Zone by region	2	75.7	283.9	318.8
Zone by stand*region	9	51.8	116.1	92.6
Zone by point*stand*region	56	33.3	85.0	85.7
Residual	224	183.3	229.5	210.1
Total	359			

* within each. F-test significantly different: † P<0.05, ‡ P<0.01. Denominator is next lower mean square variance.

Screenometer estimates for Phase II stands are illustrated in figures 1, 2, 3 and 4. Differences among several stands were apparent. Stands to the right have higher foliage and twig screening than those to the left (fig. 2). Among stands, comparison of confidence intervals for the means among screenometer estimates suggests that there were significant differences. Actual tests of differences between stands would have to be conducted to assure statistical reliability of apparent differences.

Table 3.-- *Analysis of variance for summer 1992 nonvegetative screening 0.0 to 2.8 ft aboveground, Phase II stands*

Source	Degrees of freedom	Mean square
Region	2	225.8
Stand*region	9	124.6
Point*stand*region	56	103.5†
Residual	112	58.0
Total	179	

* = within each. F-test significantly different: † P<0.05. Denominator is next lower mean square variance.

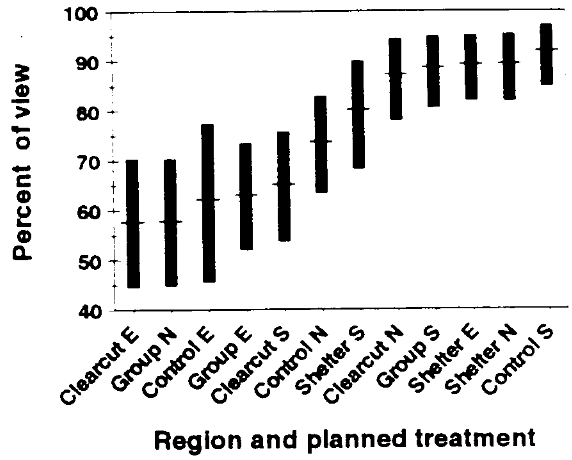

Figure 2.-- *Foliage and twig screening 0.0 to 5.5 ft aboveground, mean ±2 standard errors, by region and planned treatment, summer 1992 pretreatment conditions, Phase II stands. Region: N= north, E= east, S= south*

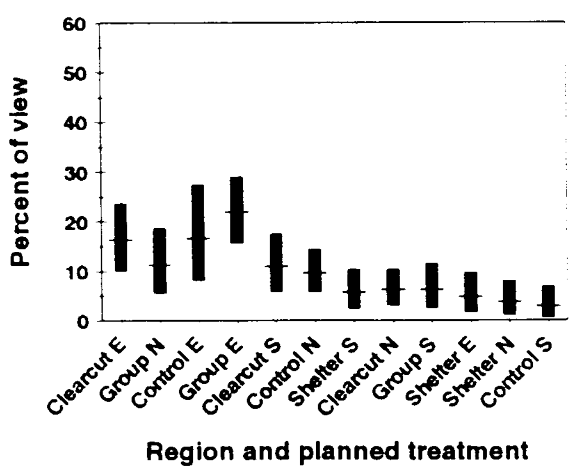

Figure 1.-- *Tree-bole screening 0.0 to 5.5 ft aboveground, mean ±2 standard errors by region and planned treatment, summer 1992 pretreatment conditions, Phase II stands. Region: N= north, E= east, S= south*

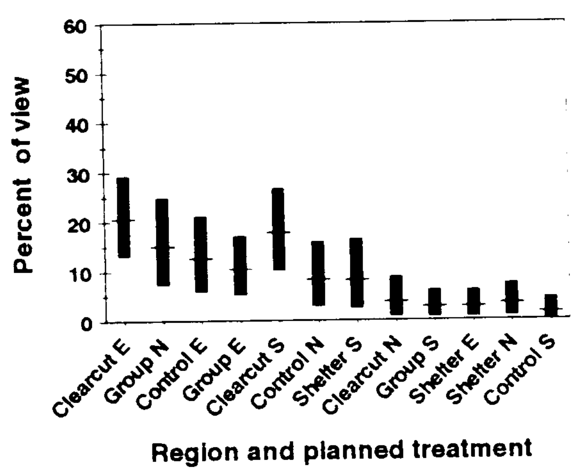

Figure 3.-- *Visual penetration 0.0 to 5.5 ft aboveground, mean ±2 standard errors, by region and planned treatment, summer 1992 pretreatment conditions, Phase II stands. Region: N= north, E= east, S= south*

From previous scenic beauty research (Ribe 1989) and studies of screening in east Texas pine stands (Ruddell and others 1989, Rudis and others 1988), we anticipate that scenes with a lower proportion of foliage and twig screening and high proportion of tree-bole screening and visual penetration will receive the highest scenic beauty ratings. Outcome of scenic beauty ratings is uncertain for stands and scenes where nonvegetative screening is present.

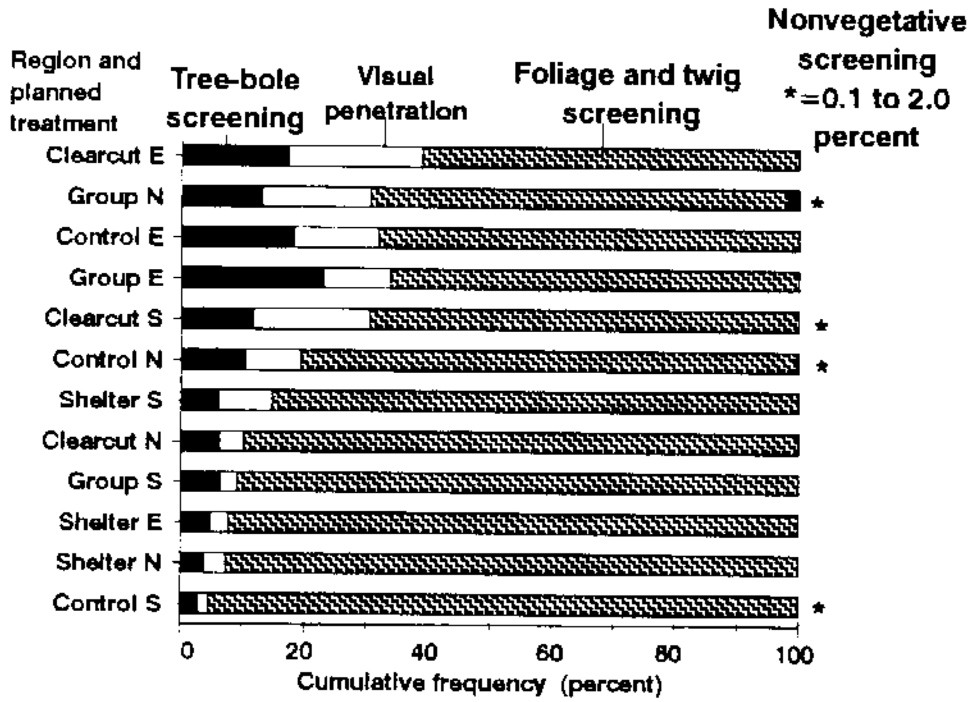

Figure 4.-- *Cumulative mean value of summer 1992 pretreatment visual attributes 0.0 to 5.5 ft aboveground by screenometer category, region and planned treatment, Phase II stands. Region: N= north, E= east, S= south*

Winona Plots

Methods.--Visual attribute conditions were examined from an ongoing plot-level study of silvicultural treatments made in January, 1989. Each plot was a 0.5-acre square area centered within a 1.1-acre treated area. Visual attribute estimates were made in 12 directions for each of 20 plots in summer and winter, beginning in summer (September 1990). For comparison with Phase II estimates, only summer data are discussed and reported here.

Screening estimates were based on 24 summer observations, comprising 12 sectors and 2 zone views. Sectors were located systematically and centered at intervals beginning with azimuths at 45 degrees from the azimuth of plot corners toward plot centers. Sectors were viewed from eight points inward toward the plot center: one at each of 4 corners of the plot and one half-way between each corner. Four sectors were also measured from the center of each plot with azimuths directed toward plot edges. Eight photographs were taken along the same azimuths as inward views used in scenic beauty assessments (Gramann and Rudis 1994).

Four blocks or landform positions with slopes ranging from 10 to 20 percent referred to elevation and slope aspect (lower north, middle north, upper north, and upper south) and corresponded to a moisture and potential microclimate or site-productivity gradient. Plots were assigned to treatments following procedures for a randomized complete block design. There were four plots harvested using uneven-aged guidelines and one unharvested plot (Control) for each landform. Treatments included alteration of existing stands to 60 square feet (ft^2) of pine basal area (BA) per acre and one of the following: 30 ft^2 BA hardwoods (Scatter 30, S30), 15 ft^2 BA hardwoods in a grouped condition (Group 15, G15), 15 ft^2 BA hardwoods in scattered condition (Scatter 15, S15), and 0 ft^2 BA hardwoods (No hwds). Initial BA ranged from 100 to 130 ft^2 BA, with the majority of BA in shortleaf pine trees approximately 70 years old. Hardwood BA consisted chiefly of oak species approximately 50 years old (Shelton and Murphy 1991). Shelton and Murphy (1990, 1991) provide other details on pretreatment stand conditions.

Results.--F-tests for analysis of variance among screenometer estimates revealed significant differences (table 4). Tree bole screening was not significantly different by view zone (P[F] $\geq$0.4).

Table 4.--*Analysis of variance for summer 1990 visual attributes by screenometer category, Winona plots*

Source	Degrees of freedom	Mean square variance by category: Tree boles	Foliage and twigs	Visual penetration
Landform	3	42.4	4,200.0‡	2,902.0‡
Treatment	4	1,782.6‡	3,736.8‡	1,997.0†
Zone	1	77.3	85,218.6‡	68,782.3‡
Zone by treatment	4	19.8	5,850.4‡	6,297.3‡
Experimental design	27	137.4	793.8‡	553.1†
Residual	440	161.3	381.0	356.8
Total	479			

F-test significantly different: † P<0.05, ‡ P<0.01. Denominator is residual sampling variance for the experimental design and experimental design for other variances.

Tree-bole screening means were significantly different (P|t| < 0.05) between substantially undisturbed (Control and S30) and more disturbed (G15, S15, and No hwds) plots (fig. 5). Zone differences were significant for foliage and twig screening (fig. 6) and visual penetration (fig. 7). Differences were largest for foliage and twig screening between untreated (Control) and disturbed plots in the upper zone, and among substantially undisturbed (Control and S30), somewhat disturbed (G15 and S15), and more disturbed (No hwds) plots in the lower zone (fig. 6). The three visual attributes are summarized in figure 8.

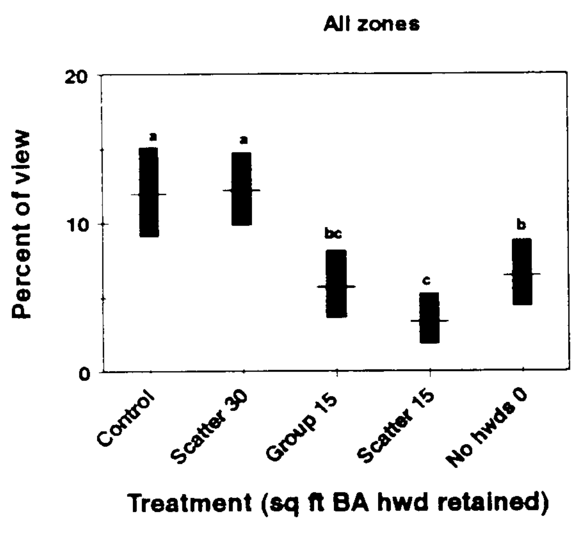

Figure 5.-- *Tree-bole screening 0.0 to 5.5 ft aboveground, mean ±2 standard errors by treatment, summer 1990, Winona plots. Means with the same letter are not significantly different (P|t| >0.05)*

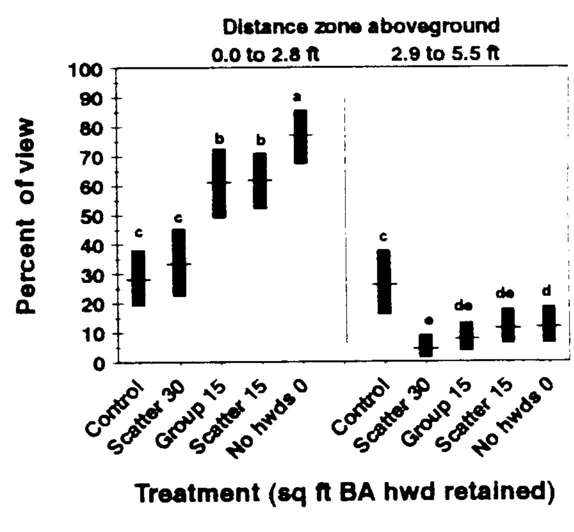

Figure 6.-- *Foliage and twig screening, mean ±2 standard errors, by treatment and zone (distance aboveground), summer 1990, Winona plots. Means with the same letter are not significantly different (P|t| >0.05)*

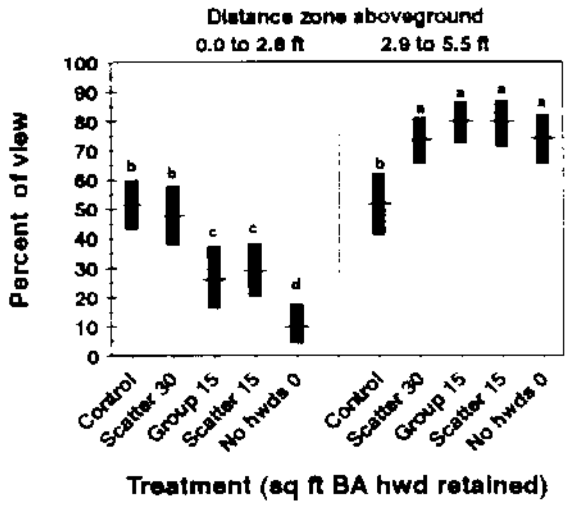

Figure 7.-- *Visual penetration, mean ±2 standard errors, by treatment and zone (distance aboveground), summer 1990, Winona plots. Means with the same letter are not significantly different (P|t| >0.05)*

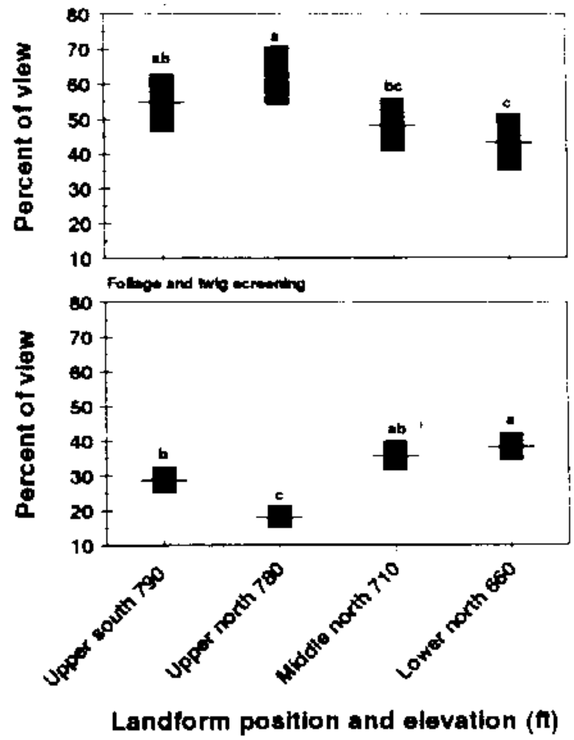

Figure 9.-- *Visual penetration and foliage and twig screening, mean ±2 standard errors, by landform position and elevation, summer 1990, Winona plots. Within each visual attribute, means with the same letter are not significantly different (P|t| >0.05)*

Landform variance was significant for foliage and twig screening and visual penetration. Differences were largest between lower and upper landform positions (fig. 9). The experimental design variance was significant. Because landform interaction was not replicated, statistical examination of interaction with other sources of variation was not possible. Mean values among the three visual attributes varied widely by treatment and landform (fig. 10).

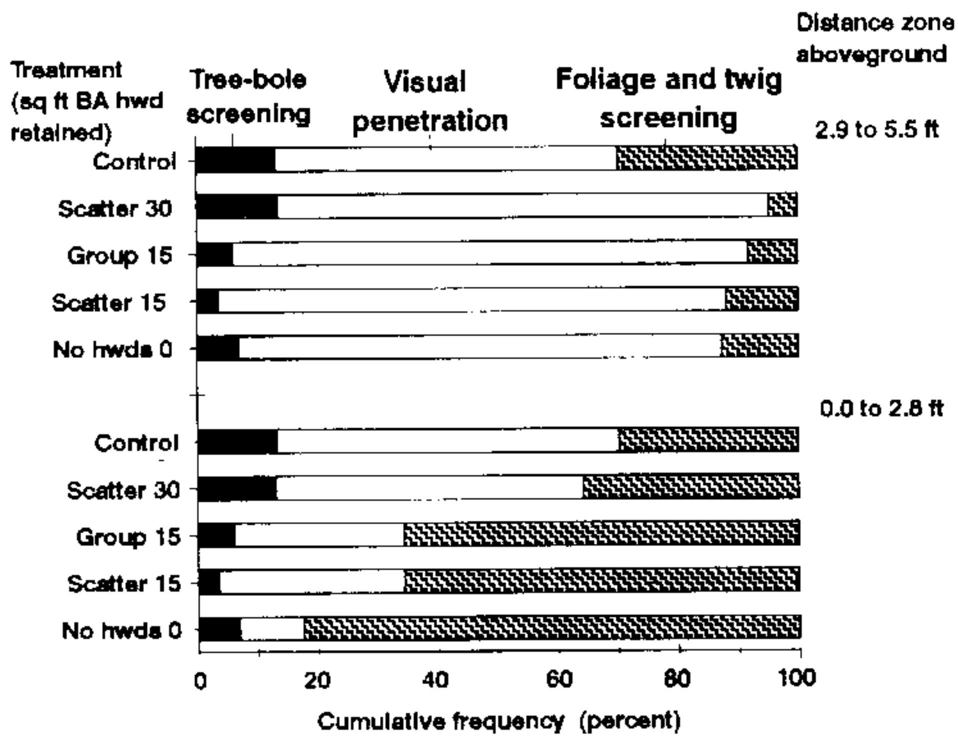

Figure 8.-- *Cumulative mean value of summer 1990 visual attributes by screenometer and zone (distance aboveground) category, Winona plots*

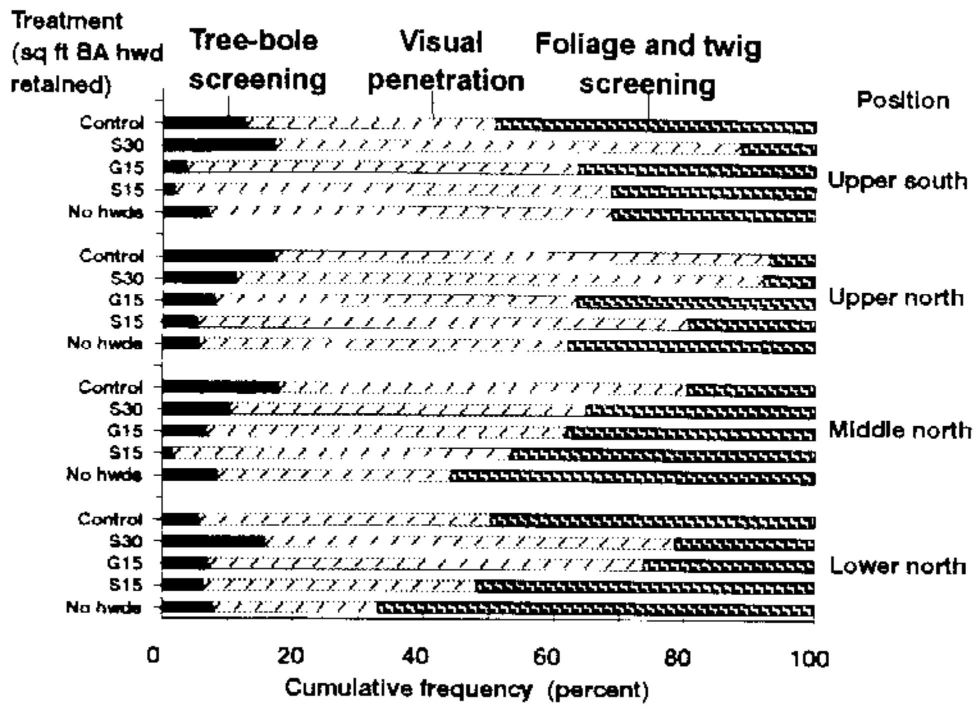

Figure 10.-- *Cumulative mean value of summer 1990 visual attributes by screenometer category, treatment, and landfo position, Winona plots*

DISCUSSION AND CONCLUSIONS

No significant vegetative screening and visual penetration differences between upper and lower zones in pretreatme Phase II stands or Winona control plots were found. Only disturbed plots had significant zonal differences. We hypothesi that Phase II stand-level treatments will create zonal differences in summer visual attributes. The lack of differences amo zones may be a useful gauge of a stand's recovery from treatments for comparable pine-hardwood stands in the Ouachi Mountains. Significant summer visual attribute differences between zones may be indicative of recent disturbance. Wi additional study elsewhere, visual attribute zone differences could serve as disturbance detection indices for stands with known historical records.

Phase II Stands

Although the pretreatment sample design for Phase II stands considered point location as a random effect, significa differences in visual attributes were noted among sample points within stands. This finding suggests the need to furth characterize point-location attributes and to consider points as fixed effects after treatments have been applied. Additio examination of visual attributes and scenic beauty measures by point before and after treatment may reveal signific differences in the diversity of scenic beauty values within stands.

Nonvegetative screening as a visual attribute may be important in estimating scenic beauty ratings and treatments stands with steep terrain. However, previous visual attribute studies either occurred on gentle slopes, flat topography, did not separate view zones. Group north, located on one of Arkansas' highest elevations (Mount Magazine), was one the few stands with nonvegetative screening and the only stand examined with >1-percent nonvegetative screening. Gro north's location, steep slopes, limited occurrence of understory foliage and twigs, and lack of obvious evidence of pr cutting activity (Rudis, personal observation) may make it unique in comparison to other stands in this study.

Winona Plots

Winona plot analysis indicated that foliage and twig screening in the lower zone view increases and visual penetrati decreases with stand disturbance. Two-year old disturbances continued to maintain greater visual penetration above 2.8

The increase in sunlight and subsequent vegetative growth could account for most of the decline in visual penetration in the lower zone. The potentially drier and less fertile microclimate on higher landform positions may account for reduced foliage and twig screening and increased visual penetration when compared with lower landform positions.

Having no estimates of visual attributes before disturbance and no replication of landform interaction, we can only speculate on the landform relationship with treatment. We hypothesize that the favorable microclimate in the middle north and lower north landform positions enhances the vegetative recovery of recently disturbed forests, resulting in greater foliage and twig screening than in upper north and upper south positions. In future studies, sampling designs that permit statistical tests of the relationship among landform, treatment, and zones would be desirable.

From personal observation, some debris and forest floor disturbance from treatment activities were present. Debris included dead twigs, branches, and tree tops--all of which was included in foliage and twig screening. Scenic beauty ratings for Winona plots decline with increasing intensity of disturbance (Gramann and Rudis 1994). We conclude that, two growing seasons after disturbance, mitigating disturbance impacts on esthetics include removal of debris associated with lower zone foliage and twig screening.

The choice between retaining 15 ft^2 of hardwoods scattered (S15) or grouped (G15) is important from a silvicultural perspective and may be important from an esthetics perspective. From scenic beauty evaluation, G15 yields higher scenic beauty ratings (Gramann and Rudis 1994). Statistical tests for each of the three visual attributes failed to distinguish significant differences for foliage and twig screening ($P|t| = 0.38$) and visual penetration ($P|t| = 0.63$). However, there was a marginally significant ($P|t| = 0.07$) and higher proportion of tree boles visible in the grouped than in the scattered treatment. We know that tree-bole screening contributes positively to scenic beauty ratings (Rudis and others 1988), and conclude that grouping hardwoods has a marginal esthetic advantage. The mechanism remains unclear, however. We suggest group retention of hardwoods increases the number of views dominated by tree boles, on average, when compared with views from areas where retention of hardwoods is scattered.

Mitigating silvicultural alternatives might include retaining shade-producing overstory trees to suppress summer growth of understory foliage, periodic removal of unwanted foliage that screens the view, and removal of downed woody material from the forest floor. However, downed woody material assessment, examination of visual attributes in other seasons after plots have recovered from disturbance, and more detailed investigation of landform position are warranted. Such studies are needed before recommendations can be generalized beyond this initial examination.

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