Tres Piedras Piñon-Juniper Silviculture: A Partnership Project Between the USDA Forest Service and New Mexico State University

John T. Harrington[1], Jim Fitch[2], and Patrick A. Glass[3]

Abstract.—In 1993, a Partnership Agreement was made between the Carson National Forest and New Mexico State University to examine the effects of thinning intensity on piñon-juniper woodland ecology on the Tres Piedras Ranger District. The goal of the project is to evaluate fuelwood harvesting effects on the regeneration of overstory species, wood production, and herbaceous ground cover. The project area had been harvested in large blocks, 60 to 90 ha, from 1979 through 1990. Preliminary surveys of the area indicate that these blocks were relatively uniform in initial basal area and edaphic conditions. This area provides an ideal laboratory for evaluating the effects of thinning intensity on the ecological processes on piñon-juniper ecosystems.

INTRODUCTION

The piñon-juniper woodlands of the southwestern United States have, and continue to satisfy many of man's needs. This utilization occurred well before written records existed, with estimates of up to 20,000 years before present (Buckman and Wolters 1987). Use of the piñon-juniper woodlands includes the harvesting of tangible products as well as satisfying religious, spiritual and cultural needs (Miller and Albert 1993). Commonly harvested products include; products from the trees themselves such as fuelwood, fence posts, piñon nuts and juniper berries. Other products harvested from the piñon-juniper woodlands include; wildlife, forage for livestock and water via the watersheds encompassed by the woodlands. Non-material uses of the piñon-juniper woodlands include recreation, including wildlife watching and hiking, and the spiritual and cultural associations many Native American groups have with these woodlands.

The piñon-juniper woodlands of the southwest are fast becoming recognized as one of the regions more valuable natural assets. The pressure on these woodlands for the products and uses stated above is increasing with the increasing population of the southwest. As this pressure escalates, the likelihood of a long-term disruption in the administration of the woodlands also escalates. This is especially true for the piñon-juniper woodlands administered by public land agencies who need to address the needs of many, sometimes divergent, user groups. The U.S.D.A. Forest Service has been developing sustainable, multi-resource management strategies for piñon-juniper woodlands to address these changing needs (Buckman and Wolters 1987, Tidwell 1987).

Administration of these woodlands can be perplexing. The relatively slow and poorly understood ecosystem dynamics of the piñon-juniper woodlands increase the difficulty of evaluating an administrative decision with regard to the ecosystem health of these woodlands. This point necessitates that the administration of piñon-juniper woodlands be based on an understanding of the biological and ecological processes of the woodlands. However, studying an ecosystem and

[1] *Assistant Professor of Tree Physiology and Superintendent of the Mora Research Center, New Mexico State University.*
[2] *Silviculturist, USDA Forest Service, Carson National Forest.*
[3] *Senior Research Assistant, Mora Research Center, New Mexico State University.*

generating meaningful information to assist land managers can be quite costly. Buckman and Wolters (1987) noted that direct Federal funding for such studies is somewhat restricted. Understanding such restrictions and recognizing the need for such information on the piñon-juniper woodlands, the Carson National Forest and New Mexico State University entered into a Partnership Agreement in 1993. The Partnership Agreement provided a mechanism for the two organizations to collaborate without the exchange of funds.

THE PARTNERSHIP AGREEMENT

Project Location

The project site is located on the Tres Piedras Ranger District of the Carson National Forest in northern New Mexico. Specifically, the project area is south of the town of Tres Piedras, NM (Figure 1). The Comanche Rim is the western border of the project area and U.S. Highway 285 is the eastern boundary with the exception of the 1990 thinning unit which is immediately east of the highway (Figure 2).

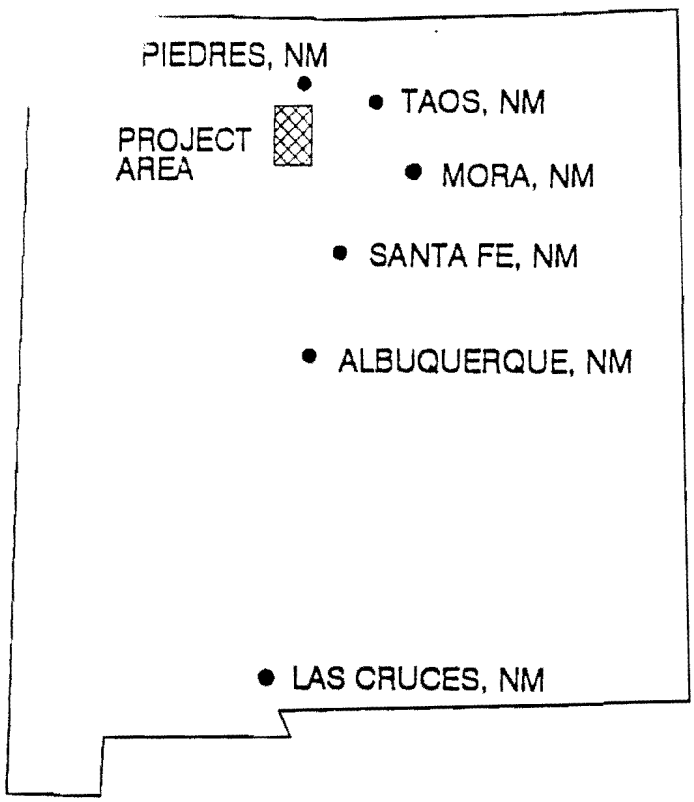
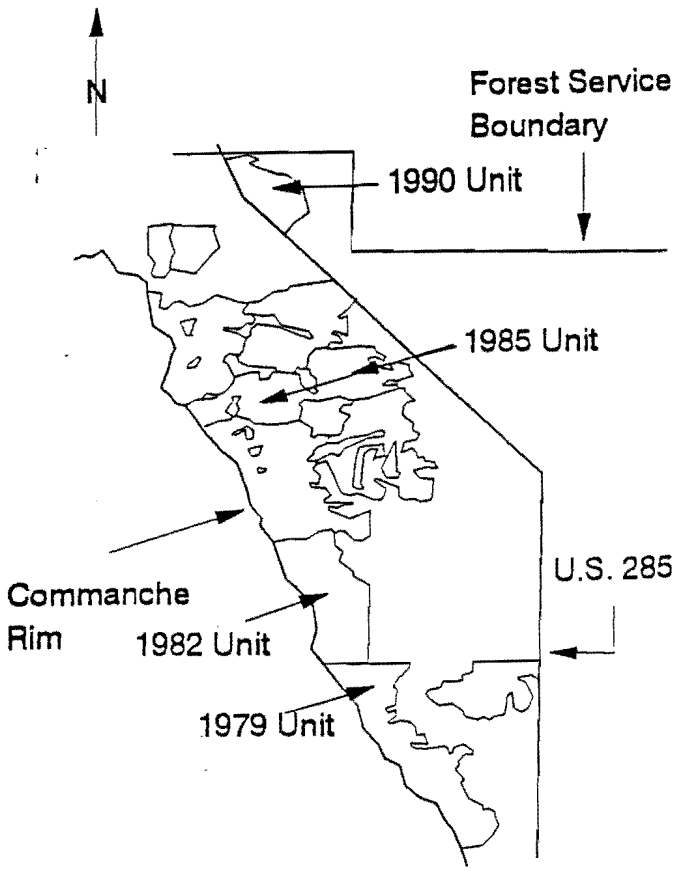


Figure 1.—Location map of the Tres Piedras piñon-juniper project area.



Site History

There are approximately 4,035,340 ha of piñon-juniper woodlands in New Mexico (Fowler et al. 1984). The Carson National Forest administers approximately 135,970 ha of piñon-juniper woodlands (CNF Plan Amend 7, 1990). Approximately 16% of the piñon-juniper woodlands administered by the Carson National Forest are within the Tres Piedras Ranger District.

There is extensive evidence of man's presence in the project area. Archeological surveys of the area indicate that hunter-gathers initially used the area during the Archaic Period (5,000 - 0 B.C.) with lithic scatters being the predominate form of archeological site (Elder 1994). European man's arrival in the area appears to be associated with the arrival of the southern spur of the Denver & Rio Grande Railroad in the 1880's (Carpenter 1994). A good review of this period can be found in *Logging on the Denver and Rio Grande* by Chappell. There is also evidence of wood cutting activity in the past as indicated by old, large stumps from trees felled by axes. Using Budy and Meeuwig's (1987) classification, these stands would be classified as old-growth, high-graded stands.

In 1979, the Tres Piedras Ranger District and the Carson National Forest initiated a program of thinnings in the project area. The initial prescription was to thin the stands to a residual spacing ranging from 6 x 6 m to 12 x 12 m (20' x 20' to 40' x 40'). Leave trees were chosen primarily on the criteria of form. The intent to generate an uneven-aged or even-aged condition is ambiguous, however, this approach closely resembles Bassett's (1987) classification of a 2-step shelterwood system.

The thinnings which were imposed were not initially designed as a research study, but rather as a management prescription. The trees were marked for removal by several different Forest Service personnel over the time of the thinnings. The trees were felled and removed by the general public, predominately in the form of fuelwood. Many of the marked trees however, were not removed. This combination of different marking personnel and variable tree removal resulted in a wide variation of thinning intensities imposed on the project area. Also, the high frequency of archeological sites in the project area left many areas undisturbed by the thinning activity. These undisturbed areas, of variable sizes, could possibly satisfy the needs of control plots depending on their size.

The project area was also under an active grazing program prior to beginning the thinnings and throughout the thinning treatments. The project area continues to be grazed by livestock today.

Project History

In the Spring of 1992, the Carson National Forest Silviculturist, Jim Fitch and myself (John Harrington) visited the project area to discuss piñon-juniper silviculture alternatives for the Carson National Forest. Following several additional visits to the project area, we concluded that post-treatment measurements of the thinning treatments were needed in order to assess the effects of the treatments. There was enough variability in thinning intensity during each year's treatment that we felt useful information could be generated regarding thinning intensity effects on the woodlands.

In mid-summer of 1992 we met with the Tres Piedras District Ranger and staff to discuss alternatives to evaluate the thinning treatments. It was concluded during these meetings that the likelihood of independent funding for the project would be limited. However, by combining the two organizations resources we could achieve the mutual objectives of both organizations. Over the next nine months a Partnership Agreement was drafted and submitted for approval by New Mexico State University and the Carson National Forest. On October 20, 1993, with the signature of the Carson National Forest Supervisor, the Tres Piedras Piñon-Juniper Partnership Agreement was approved.

Project Goals and Objectives

The Partnership Agreement set four broad goals to be achieved. These goals were:

1. To develop a database on the piñon-juniper woodlands in the project area.
2. To examine the impacts of thinning intensity on ecological processes in the piñon-juniper woodlands.
3. To develop an efficient, and thorough plot inventory procedure that can supply information to assist in administrative land management planning; to help create a database of ecological and biological information to be used in continuing research endeavors.
4. The establishment of permanent plots in the piñon-juniper woodlands on the Carson National Forest, Tres Piedras Ranger District.

The situation on the project area lent itself well to a replicated treatment study over time. However, to ensure there is in fact replication of treatments over time, several assumptions needed to be made and validated. These assumptions were:

1. The different thinning years were on similar sites with similar initial site and stand conditions. These similarities include similar edaphic and climatic properties as well as similar stand structures prior to thinning treatments; (i.e. the treatments were imposed on one initial population).
2. Each thinning year had similar variability in thinning intensity; (i.e. replication of treatments over time).
3. There was sufficient magnitude in thinning intensity whereas replicate plots of each thinning intensity could be located in each thinning year; (i.e. sufficient within year replication of treatments).

Project Structure

The project is divided into two phases. The first phase involves the validation of the assumptions,

obtaining preliminary wood fiber production effects of the thinning and obtaining the information necessary to design the second phase of the project. The second phase involves the bulk of the work towards the attainment of the main goals of the project.

Phase 1

Objectives

The specific objectives of the first phase of the project are:

1. To determine the magnitude and range of thinning intensity (based on ground line basal area) on the project area.
2. To provide variability information necessary to design the second phase of the project area.
3. To locate plots for use in the second phase of the project.
4. To generate preliminary data on the diameter growth response of residual trees.

Materials and Methods

Thinning Unit Determination—The project area had annual thinning tracts from 1979 through 1990. Each tract was cut during the late summer and fall (mid August through September). An exception to this was part of the 1988 thinning tract which was re-entered in 1989. Thinning years 1979, 1982, 1985, 1990 and the portion of the 1988 thinning tract not re-entered in 1989 were selected for initial inclusion in the project. A minimum of 25 plots were to be established in each of the five selected thinning years.

Thinning area boundaries were determined using aerial photograph interpretation from the 1990 air survey of the area and from records located at the Tres Piedras Ranger District office. Thinning unit boundaries were delineated on acetate overlays of the aerial photographs (scale = 1:12,000) and areas calculated using a Summagraphics digitizing table.

Following area size determination, plot locations were determined by randomly dropping a dot grid over the 1990 aerial photographs of each thinning unit. The distance between each dot was 5 chains. To sufficiently cover each thinning unit and satisfy the minimum number of plots for each thinning unit, a distance of 10 chains was used within and between plot transects.

Plot Procedure—At each plot center a 202 m^2 ($1/20^{th}$ acre) fixed radius plot was established. Plot center was marked initially with a wooden stake. (During subsequent visits to the plots, plot center was reestablished with 0.7 m steel marker and a plot tree was tagged using a 5 cm aluminum tag). The fixed radius plot had a radius of 8.02 m (26.3 feet).

Species and ground line diameter was recorded for all standing trees and stumps greater than 2.5 cm (1") within the plot boundary. Ground line diameters were measured using tree calipers. Also, all advanced regeneration (possessing secondary needles but less than 5 cm ground line diameter) was recorded for the plot. Estimation of the number of seedlings not considered as advanced regeneration was also recorded.

Wood cores were taken from two overstory piñon trees at each plot. Cores were taken at a height of 1.37 m (4.5 feet) from the ground. Cores were placed in plastic drinking straws labeled with the appropriate plot information. Trees for coring were selected using the following system. The first piñon encountered proceeding clockwise from the north radius and the first piñon encountered proceeding clockwise from the south radius.

Data Analysis—Ground line diameter data was used to determine current plot basal area and estimate the basal area removed in the thinning treatment. These two values were combined to estimate the initial basal area prior to the thinning treatments. Graphic analysis and non-parametric analysis procedures (Wilcoxon Rank Sums and Kruskal-Wallis Test) were used to compare the distributions from each thinning year of the initial basal areas and thinning treatment intensities. All analysis were performed using the SAS 6.03 statistical analysis software programs (SAS Institute, Cary, NC).

Tree cores were analyzed in the laboratory to determine tree age and annual increment from 1969 to the present (fall/winter 1993). Cores were extracted from the plastic straws and stained using a phloroglucinol staining procedure as outlined by Patterson (1959). Annual ring widths were measured for the previous 25 growing seasons (1969 through 1993) to provide reference contrasts from site to site with regard to diameter growth rates. Ring widths were measured under a binocular dissecting microscope using a 1.2 magnification setting with 10X ocular lenses. One standard ocular lens was replaced with a 10X calibrated ocular. The calibrated lens allowed for the determination of ring widths to the nearest 0.1mm.

PRELIMINARY RESULTS

The 202 m^2 acre plots of the first phase have been established. Analysis of the data from these plots is still being conducted. Initial evaluation of initial basal area indicate that the 1988 thinning unit was not similar with regards to basal area prior to the thinning treatment. Both non-parametric procedures used to

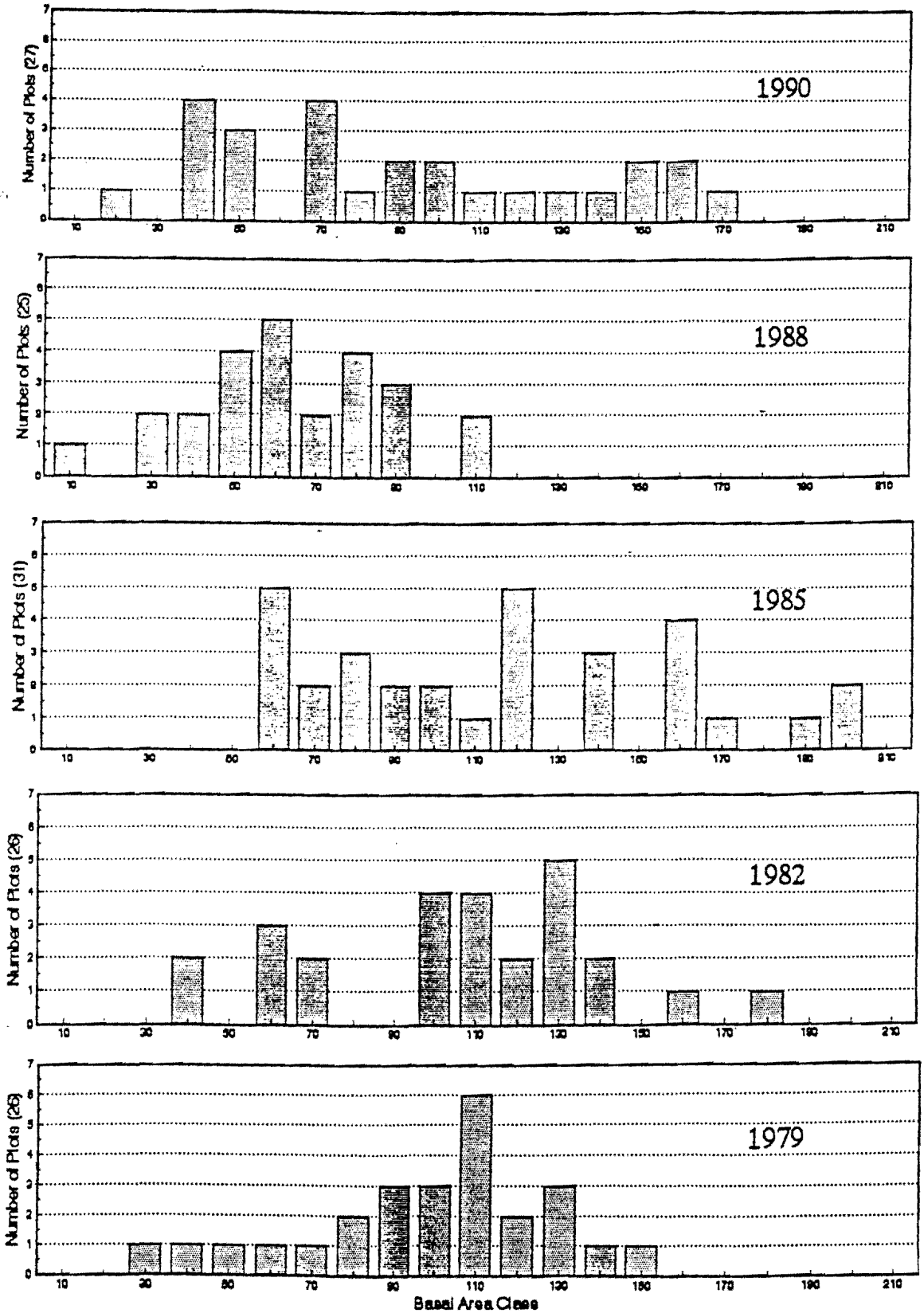


Figure 3.—Calculated initial ground line basal areas of the thinning units. Values on X-axis indicate the median of the bar range. The 1988 thinning units has 13 uncut control plots.

evaluate the initial basal area data indicated the 1988 thinning unit did not have the same distribution as other four thinning units. The initial basal area of the 1988 thinning unit ranged from 10 ft^2/ac to 110 ft^2/ac (Figure 3). The initial basal area for the remaining four thinning years being evaluated, 1979, 1982, 1985, and 1990, ranged from 20 ft^2/ac to 200 ft^2/ac (Figure 3).

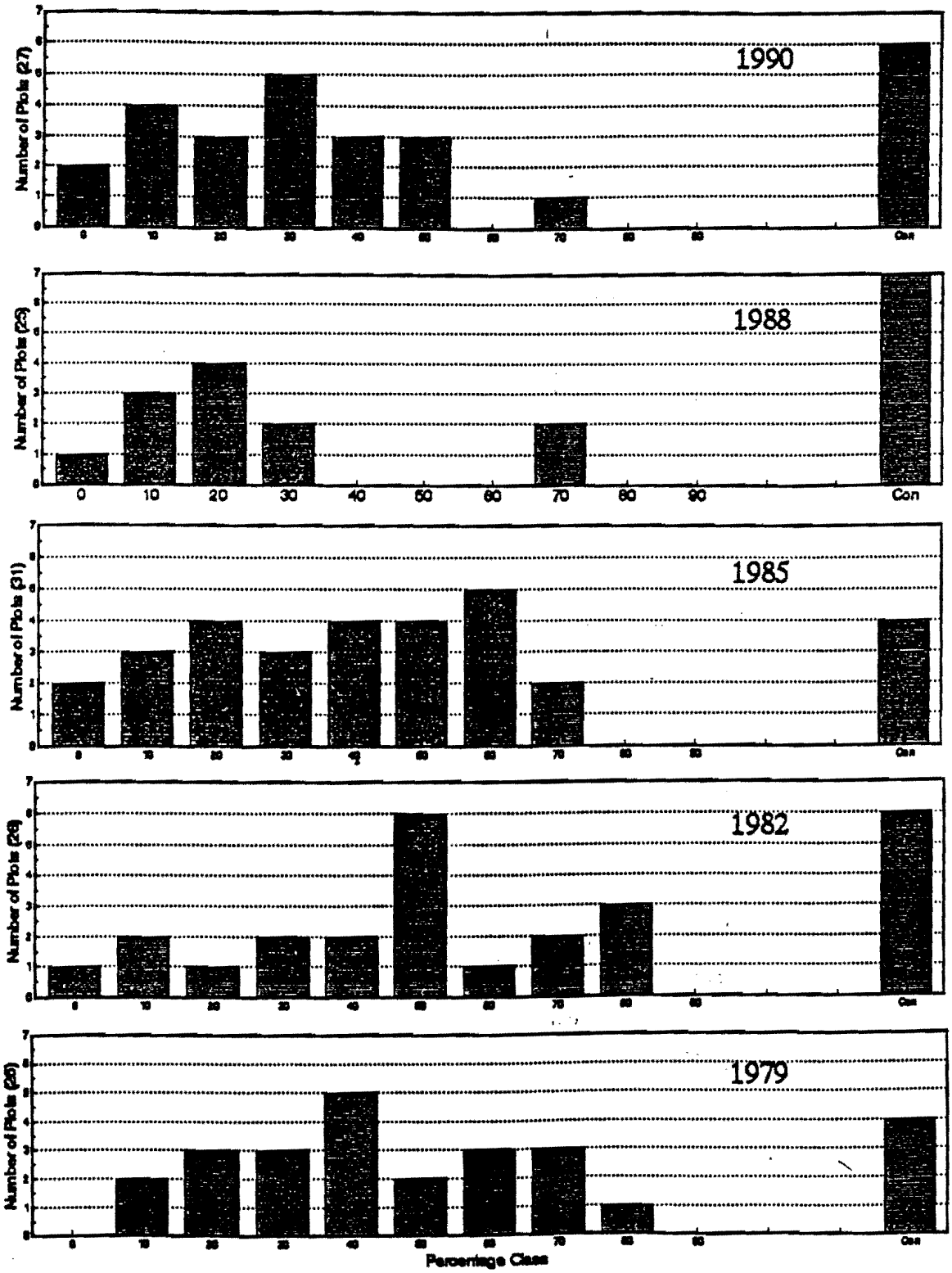


Figure 4.—Percent of initial basal area removed by plot frequency for the 1979, 1982, 1985, 1988, and 1990 thinning units.

The non-parametric analysis of the percent of initial basal area removed (thinning intensity) also indicated that the 1988 thinning year was not representative of the other 4 thinning years being examined. This discrepancy of the 1988 harvest can also be seen graphically. Only 2 of the 25 plots measured had greater than 30% of the initial basal area removed (Figure 4). The other 4 thinning years had a much greater frequency of heavier harvests (Figure 4).

Phase 2

Objectives

The objectives of the second phase of the project are less defined at this point. Specific objectives will not be developed until the analysis of the first phase data is complete. However, several areas which will be addressed have been defined. These areas include:

1. Examination and evaluation of spatial and temporal trends in regeneration conditions involving overstory species.
2. Examination and evaluation of edaphic and microsite factors impacting regeneration of overstory species.
3. Examination and evaluation of the diversity and abundance of herbaceous ground cover.
4. Examination and evaluation of the wood fiber response in residual overstory species.
5. To provide a thorough inventory (database) of species present and their distribution on the sites for the establishment of long-term studies.

Materials and Methods

Exact plot procedures have not yet been determined for this phase of the project. However, it will involve a combination of fixed size plot and variable size plot techniques to satisfy the objectives of this phase.

SUMMARY

The work thus far indicates that the 1988 thinning year will not be part of the replication study. Further evaluation of the age and diameter growth data will provide further information on whether the four remaining thinnings units can be considered as originating from a single population. Also, the analysis of the tree ring data will provide some preliminary information as to the effects of the first entry removals on residual trees.

Completion of the first phase should be done by November 1994. Field work should begin on the second phase early in the Spring of 1995.

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