Effects of Thinnings on Growth and Yield in Natural *Pinus Arizonica* and *Pinus Durangensis* Stands in the El Largo-Madera Region in Chihuahua State

Oscar Estrada Murrieta,[1] Luis A. Domínguez Pereda,[2] and Marcelo Zepeda Bautista[3]

Abstract.—This paper presents the result of the first dasometric analysis made with the data of some permanent thinning plots established at different times since 1964 in the Unit of Conservation and Forest Development #2 in Chihuahua State, Mexico. The results show the benefits of thinnings on the growth rates of residual stands, the increment's redistribution, and the potential mortality.

INTRODUCTION

The need to know the dynamics of the forest through time, the direct and indirect impacts of humans, and natural disturbance agents has moved many foresters all over the world to establish and periodically measure different kinds of plots, which we call "permanent sites or plots."

In Mexico, interest in following the steps of forest growth moved the technical staff of the Unit of Conservation and Forest Development (UCODEFO)#2 "El Largo-Madera" to establish several permanent plots since 1964 in this Unit.

The plots were named, according to their objectives, "observation," "demonstrative," and "experimental."

Some of these plots can be criticized from the statistic point of view. However, they are practical in representing some silvicultural conditions of the "El Largo-Madera" region, and they have a historic value because they are the only ones of their kind in the UCODEFO #2 region that have been measured many times. To avoid confusion in this paper, we call all the plots "Parcelas Permanentes de Observación Silvícola" (PPOS).

Each PPOS's group is representative of a specific silvicultural condition of all that exists in the area. That's why the analysis is so useful. It enables us to know more about the growing dynamic of the presented conditions and, of course, to back up management decisions for similar areas.

This paper presents the results of basic dasometric analysis of the PPOS.

DESCRIPTION OF THE AREA

The area of the UCODEFO #2 is located in the Northwest part of Chihuahua State, between the meridians 108º 5' and 108º 45' to the west of Greenwich's Meridian, and between the parallels 28º 45' and 30º 00' of North Latitude (fig. 1).

The UCODEFO #2 is situated in the "Sierra Madre Occidental" and it is mainly forestry land. It is shaped of ravines and large mesetas and the altitude is between 5,900 and 9,400 feet. There are many streams and rivers. Although all the rivers

[1]*Subdelegado Forestal y de Fauna Silvestre en el Estado de Chihuahua.*

[2]*Director Técnico Forestal. UCODEFO #2 "El Largo-Madera" Chihuahua.*

[3]*Profesor Investigador. Universidad Autónoma de Chapingo. Chapingo, México.*

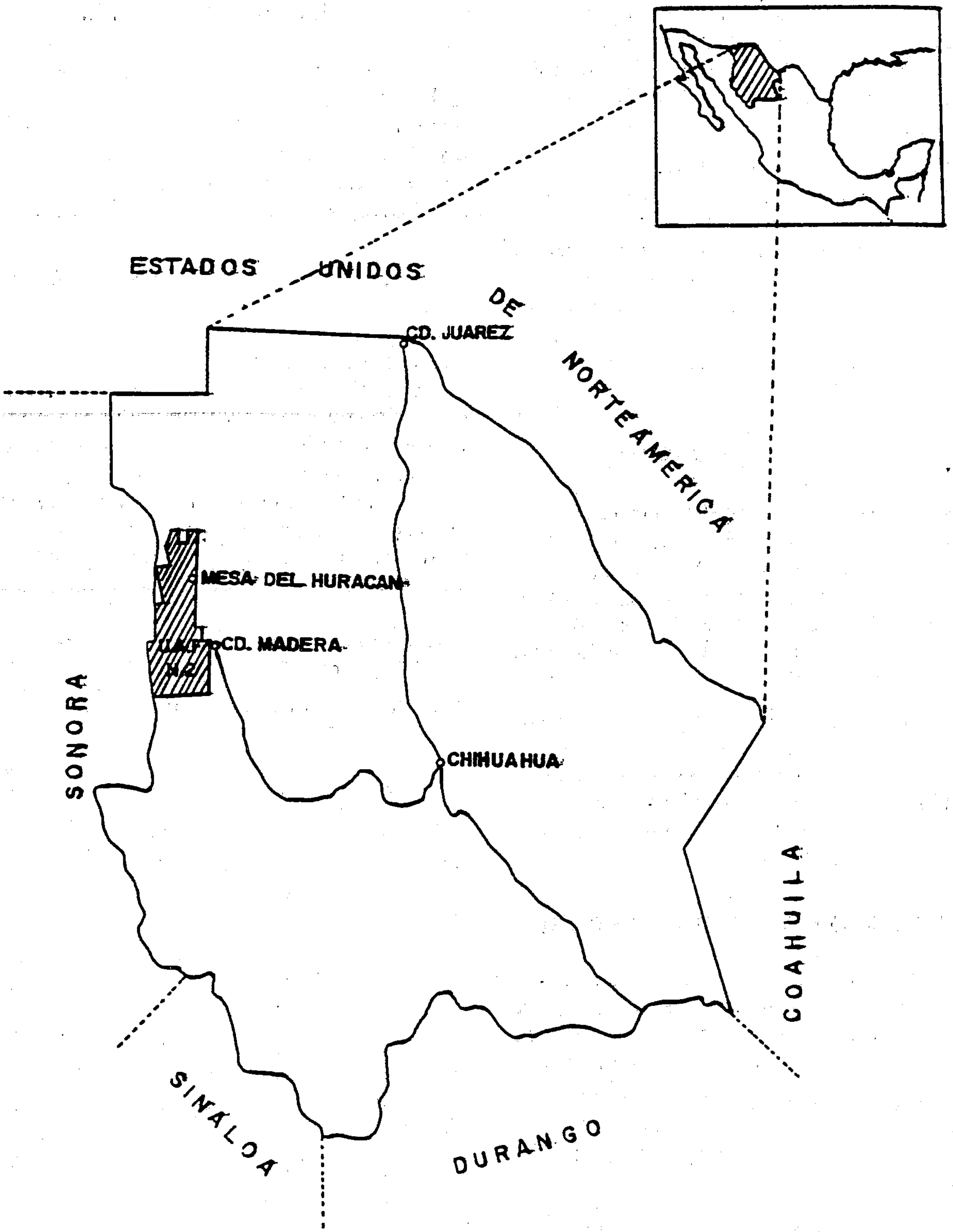

Figure 1.—Ulicación del área de estudio.

are permanent, they transport very little water in the dry season, mostly in the upper part of the watersheds.

The soils are volcanic, brown, red, gray, and combinations of these. Depth is from 0 to 65 inches and the average is 18 inches. Predominant materials are rocks and flat stones. The texture is clay, clay-sandy.

The maximum average temperature is 50.7° F and the minimum average is 35.6° F. The coldest months are January and February. Freezes are normal beginning in October. The average number of freeze days is 152 and the average amount of rain during a year is 32 inches. The summer rainy season begins in late June to late September, and the winter rainy season is from late November to March.

FOREST CHARACTERISTICS

The forests are composed mostly of pure or almost pure even-aged natural stands. The main tree species are *Pinus arizonica, Pinus durangensis,* and *Pinus engelmannii.* The structure presents two height classes. The higher is from the original forest and the lower is composed of second-growth forest, growing in high densities.

Such density indicates the need to manage those forests under a thinnings regime. This creates the need to have permanent plots to test several silvicultural treatments to know the effects of those treatments on the residual stands. Table 1 shows some control data of PPOS.

CAPTURE AND DEPURATION OF DATA

The dasometric data of the PPOS, gathered at different times, were captured in a magnetic device using a data base program. The data were captured in an easy way in 20 small data bases as follows:

Observation plots:	5 files (PARCO? .DTS)
Demostrative plots:	5 files (PARCD?. DTS
Experimental plots:	10 files (PARCE?. DTS)
Total:	20 files.

The symbol "?" correspond to a "substitute," i.e., a variable that takes in each case its value to the plot number. Once all the data were captured, we compared it and corrected it until the database was depurated.

STATISTICAL ANALYSIS

This was to get the average, variation, and totals, DBH, total height, number of trees, basal area, and volume by area unit. We also sought to graphically display the behavior of each variable over time. To do that, we preparee the computer programs, some on SAS language and other on turbo-pascal.

SUMMARY AND CONCLUSIONS

The question that always comes up in managing forest resources for timber objectives, What is the effect of thinnings over time on production and yield of the forest? As shown in the attached charts, we can see the historic behavior of the four growth forms (diameter, height, basal area, and volume) for some of the PPOS in this analysis. Included are the responses to intermediate cuts and the effect of these on accumulated growth for each of the four forms.

Table 1.—Characteristics of three permanent plots.

Plot	Type	Square feet	Date	Age * (years)	Species (pines)
1	0	4,300	April '64	20	*arizonica* *durangensis*
2	0	4,300	April '64	18	*arizonica*
3	0	4,300	April '64	16	*arizonica*
4	0	4,300	April '64	16	*arizonica*
5	0	4,300	April '64	16	*arizonica*
1	D	53,820	April '78	27	*arizónica*
2	D	53,820	April '79	24	*durangensis*
3	D	53,820	April '80	31	*durangensis*
4	D	53,820	April '79	26	*durangensis*
5	D	53,820	April '80	26	*arizónica*
1	E	6,730	April '70	25	*durangensis*
2	E	6,730	April '70	25	*durangensis*
3	E	6,730	April '70	25	*durangensis*
4	E	6,730	April '70	25	*durangensis*
5	E	6,730	April '70	25	*durangensis*
7	E	6,730	Sept. '70	25	*durangensis*
8	E	6,730	Sept. '70	25	*durangensis*
9	E	6,730	Sept. '70	25	*durangensis*
10	E	6,730	Sept. '70	25	*durangensis*
C	E	6,730	Sept. '70	25	*durangensis*

**Average age at the time of first measurement. C=Control; O=Observation; D=Demonstrative; E=Experimental.*

We deduce from the charts that basal area and volume are very high in all the plots. Stands at "El Largo-Madera" region have responded rapidly to intermediate cuts, and once they have recuperated from the thinning "shock," they inmediately close their crowns.

Thinning "shock" appears to pass at "El Largo-Madera" region in similar stands to those presented by the PPOS in a period of five years if they are cut at similar intensity to the PPOS. We can also speculate that these stands can resist higher cuts than those made in these plots. We know that the drastic cuts made initially were not so drastic, but in other ways they would assimilate faster cuts.

Even the density as the volume increases is very high in the three groups of plots compared with those presented in the rest of Chihuahua State's Forests. These results are good only for the conditions they represent.

In non-thinned stands, mortality is normally higher than in thinned stands, and it is possible that it is higher than if the stands were reduced in volume through incremental thinning. It is presumed that thinnings can increase the final yield of stands but not their total volume production.

Finally, it is very important to establish permanent plots to know the dynamics of the different forests. They can show more than just measurements; they can also show the behavior of individual trees. The plots described in this paper can be used as a live example from which we can get the experience to make the best management decisions for forestry technicians and landowners.

REFERENCES

Salmon, M., J.J. 1980. Influencia de la precipitación invernal en el crecimiento en altura de los pinos del grupo ponderosa en Chihuahua. Tesis Ing. Agrónomo Esp. Bosques. Universidad Autónoma Chapingo. 149 p.

Zepeda, B., E. M. 1992. Calibración de ecuaciones para estimar volumen fuste total y rollo total árbol. Unidades de Conservación y Desarrollo Forestal Nos. 2 y 10 de Chihuahua. Inédito-impreso. 12 p.

Zepeda, B., E. M., S. VERUETTE B., O. ESTRADA M., Y S. ESPARZA P., 1990. Curvas polimórficas de índice de sitio de edad base invariante para tres especies de pino del noroeste de Chihuahua. Univ. Autónoma Chapingo. Div. Ciencias Forestales. Serie Técnica. Bol. Téc. No. 25. 40 p.

EXPERIMENTAL PLOT NUMBER 1

Date	Number of trees/acre	D.B.H. in	Height ft.	Basal Area Sq. Ft./acre	Volume Cu. Ft./acre	Vol. Cut Cu. Ft./acre	Vol. Inst. Inc. Cu. Ft./acre/year
1970	350	3.46	16.89	24.36	299.08	976.61	
1975	311	5.07	20.13	45.35	636.39		67.48
1982 B.C.*	291	7.16	27.51	92.80	1,790.93	282.85	164.93
1982 A.C.**	277	7.83	28.83	77.31	1,508.00		
1985	227	8.54	33.81	91.52	2,088.24		193.41
1990 B.C.	227	10.00	37.78	128.26	3,256.57	823.40	233.66
1990 A.C.	149	10.59	38.27	94.70	2,433.17		

*Before cut

**After cut

EXPERIMENTAL PLOT NUMBER 4

Date	Number of trees/acre	D.B.H. in	Height ft.	Basal Area Sq. Ft./acre	Volume Cu. Ft./acre	Vol. Cut Cu. Ft./acre	Vol. Inst. Inc. Cu. Ft./acre/year
1970	214	4.84	21.02	29.96	468.99	341.39	
1975	207	6.65	25.68	53.20	279.19		102.03
1982 B.C.*	201	8.50	33.81	99.52	2,456.33	130.79	211.01
1982 A.C.**	181	9.56	36.08	93.46	2,325.48		
1985	181	10.11	39.22	114.02	3,092.40		255.64
1990 B.C.	181	11.45	49.65	134.09	4,561.78	1,268.38	293.87
1990 A.C.	130	11.53	49.92	96.94	3,293.40		

*Before cut

**After cut

EXPERIMENTAL PLOT NUMBER 7

Date	Number of trees/acre	D.B.H. in	Height ft.	Basal Area Sq. Ft./acre	Volume Cu. Ft./acre	Vol. Cut Cu. Ft./acre	Vol. Inst. Inc. Cu. Ft./acre/year
1970	648	5.07	25.09	95.87	1,650.91	299.31	
1975	589	6.06	30.01	123.64	2,537.62		177.34
1982 B.C.*	576	7.00	37.06	167.44	4,287.61	1,371.73	249.99
1982 A.C.**	343	7.59	37.65	113.16	2,915.88		
1985	337	8.18	43.88	127.95	3,810.91		298.34
1990 B.C.	337	9.25	48.31	163.37	5,370.64	1,086.59	311.95
1990 A.C.	246	9.64	48.87	128.87	4,284.06		

**Before cut*

***After cut*

EXPERIMENTAL PLOT NUMBER 9

Date	Number of trees/acre	D.B.H. in	Height ft.	Basal Area Sq. Ft./acre	Volume Cu. Ft./acre	Vol. Cut Cu. Ft./acre	Vol. Inst. Inc. Cu. Ft./acre/year
1970	686	3.89	19.94	62.54	914.64	12.80	
1975	680	4.76	23.41	93.78	1,595.83		136.23
1982 B.C.*	680	5.74	30.73	143.43	3,044.84	743.60	206.99
1982 A.C.**	414	6.45	31.52	101.89	2,300.89		
1985	401	6.96	37.35	102.22	3,066.91		255.22
1990 B.C.	401	7.83	42.41	146.16	4,373.68	728.74	261.35
1990 A.C.	291	8.38	43.16	120.11	3,644.93		

**Before cut*

***After cut*

EXPERIMENTAL CONTROL PLOT

Date	Number of trees/acre	D.B.H. in	Height ft.	Basal Area Sq. Ft./acre	Volume Cu. Ft./acre	Vol. Cut Cu. Ft./acre	Vol. Inst. Inc. Cu. Ft./acre/year
1970	2,383	2.55	17.51	120.31	1,910.93		
1975	2,007	3.18	21.58	152.50	2,880.48		193.90
1982 B.C.*	1,567	4.09	27.32	184.95	4,165.55		183.87
1982 A.C.**							
1985	1,302	4.64	32.27	191.56	5,044.71		292.38
1990 B.C.	919	5.66	39.16	194.54	5,921.65		175.38
1990 A.C.							

**Before cut*

***After cut*