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Thinning of Eastern Cottonwood in Missouri

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SUMMARY

In the spring of 1953, a thinning investigation was established in an eight-year-old plantation and an eight-year-old natural stand of cottonwood trees to study their development and response to thinning.

During the following 6 years it was found that:

1. Cubic-foot volume growth on the thinned plots was about the same as the growth on the unthinned plots.
2. Thinning increased the average quality of the trees because the smallest and most poorly formed trees were removed in thinning and growth was concentrated on the best trees.
3. Thinning increased the growth of trees under 8 inches d.b.h. more than those above 8 inches d.b.h.
4. Heavy thinning stimulated diameter growth of individual trees more than light thinning.
5. The net basal area change was greater on the thinned plots because fewer trees died.
6. Handling costs at the time of final harvest should be reduced by thinning as there will be fewer but larger trees to cut.

Eastern cottonwood *(Populus deltoides* Bartr.) occurs naturally over most of the eastern United States. The best growth occurs on bottomland sites of the Mississippi River and its tributaries. In recent years many plantations have been established on bottomland sites. However, practically nothing is known about how these stands respond to thinning.

In the spring of 1953 a thinning investigation was started in an eight-year-old plantation and an eight-year-old natural stand to study the development and growth of the treated stands. This bulletin summarizes six years of growth following treatment of these stands.

Thinning of Eastern Cottonwood in Missouri

OBJECTIVES

The objectives of this study were to determine the differences in rate of diameter growth, basal area growth, and volume growth, and to determine the rate of natural mortality in thinned and unthinned cottonwood stands.

DESCRIPTION OF THE STUDY

Thinning in a Plantation

Thinning was conducted in an eight-year-old plantation at the DuPont State Forest, Ashburn, Missouri (Fig. 1). The plantation lies adjacent to the Mississippi River. It was establishd in June, 1945, with 1-0 seedlings planted at 6-foot intervals in rows 10 feet apart. During the first and second growing seasons the seedlings were released from woody growth by hoeing.

The soil is Wabash silt loam, characterized by a slight degree of profile development and dark gray color. The topography is fairly level, with a slight downward slope away from the river. The plantation has been flooded at least four times since the establishment of the thinning study.

Eight square $^{1}/_{10}$-acre plots were laid out in the plantation. Each plot had an isolation strip 33 feet wide which received the same treatment as the plot. Four of these plots were thinned during the winter of 1952. Average basal area was reduced from 86 to 57 square feet per acre. Four plots were left unthinned and had an average basal area of 75 square feet per acre. Table 1 is a summary of the treatments of the study plots in both the plantation and the natural stand.

Thinning in a Natural Stand

Thinning also was conducted in an eight-year-old natural stand on the University of Missouri's Weldon Spring Experimental Forest, Weldon Spring, Missouri. The stand is located in a part of the flood plain of the Missouri River. It

Fig. 1—Cottonwood plantation after eight growing seasons, DuPont State Forest, Pike County.

TABLE 1--SUMMARY OF TREATMENTS OF THE STUDY PLOTS

	Treatment		
	Heavily Thinned	Lightly Thinned	Unthinned
DuPont			
Number of Plots	4	0	4
Size of Plots	1/10 Acre	-	1/10 Acre
Basal Area Before Thinning	86 sq. ft.	-	75 sq. ft.
Basal Area After Thinning	57 sq. ft.	-	75 sq. ft.
Weldon Spring, Block I			
Number of Plots	2	2	1
Size of Plots	1/40 Acre	1/40 Acre	1/40 Acre
Basal Area Before Thinning	104 sq. ft.	106 sq. ft.	132 sq. ft.
Basal Area After Thinning	57 sq. ft.	81 sq. ft.	132 sq. ft.
Weldon Spring, Block II			
Number of Plots	3	0	2
Size of Plots	1/40 Acre	-	1/40 Acre
Basal Area Before Thinning	79 sq. ft.	-	87 sq. ft.
Basal Area After Thinning	56 sq. ft.	-	87 sq. ft.

had received no cultural treatment prior to the establishment of this study. The soil is Sarpy very fine sandy loam which has little profile development and is light brown in color. The topography is relatively level.

During the winter of 1952, 10 square $^1/_{40}$-acre plots were laid out in the natural stand. Each plot had an isolation strip 33 feet wide which received the same treatment as the plot. The size of the plots was small because the stands were small. Larger plots would not have had an adequate isolation strip. The plots in the natural stand were separated into two blocks of 5 plots each and will be referred to as Block I and Block II. The 2 blocks were about ¼ mile apart.

In Block I, two plots were thinned from an average basal area of 104 square feet to 51 square feet per acre; two other plots were thinned from 106 to 81 square feet per acre, and the fifth plot with a basal area of 132 square feet per acre was left unthinned.

In Block II, three plots were thinned from an average basal area of 79 square feet to 56 square feet per acre. The other two plots with an average basal area of 87 square feet per acre were left unthinned.

Treatments in both the plantation and the natural stand were assigned at random. The thinning removed the smaller trees and the larger but poorly-formed trees. The better trees were kept as growing stock. Every tree left was assigned a number; a metal tag bearing this number was nailed on the tree at breast height.

The site index for both the plantation and the natural stand averaged 104. Dominant trees averaged 83 feet in height at 14 years of age.

RESULTS AND DISCUSSION

Diameter Growth

Plantation. Trees on the thinned plots grew an average of 2.7 inches in diameter in six years compared with 2.1 inches on the unthinned stands. After six years trees on the thinned plots average 10.0 inches in diameter compared with 8.9 inches for trees on the unthinned plots.

Diameter growth varied with the original diameter. Trees with larger original diameter grew more in diameter than smaller trees. Trees 5 to 8 inches d.b.h. grew at a faster rate on the thinned plots than on the unthinned plots (Table 2). No difference was found in the growth rate of the 9 and 10 inch trees on the thinned and unthinned plots. Thus the rate of growth of the dominant trees has not been affected by thinning while the growth rate of codominant and intermediate trees has been increased by thinning.

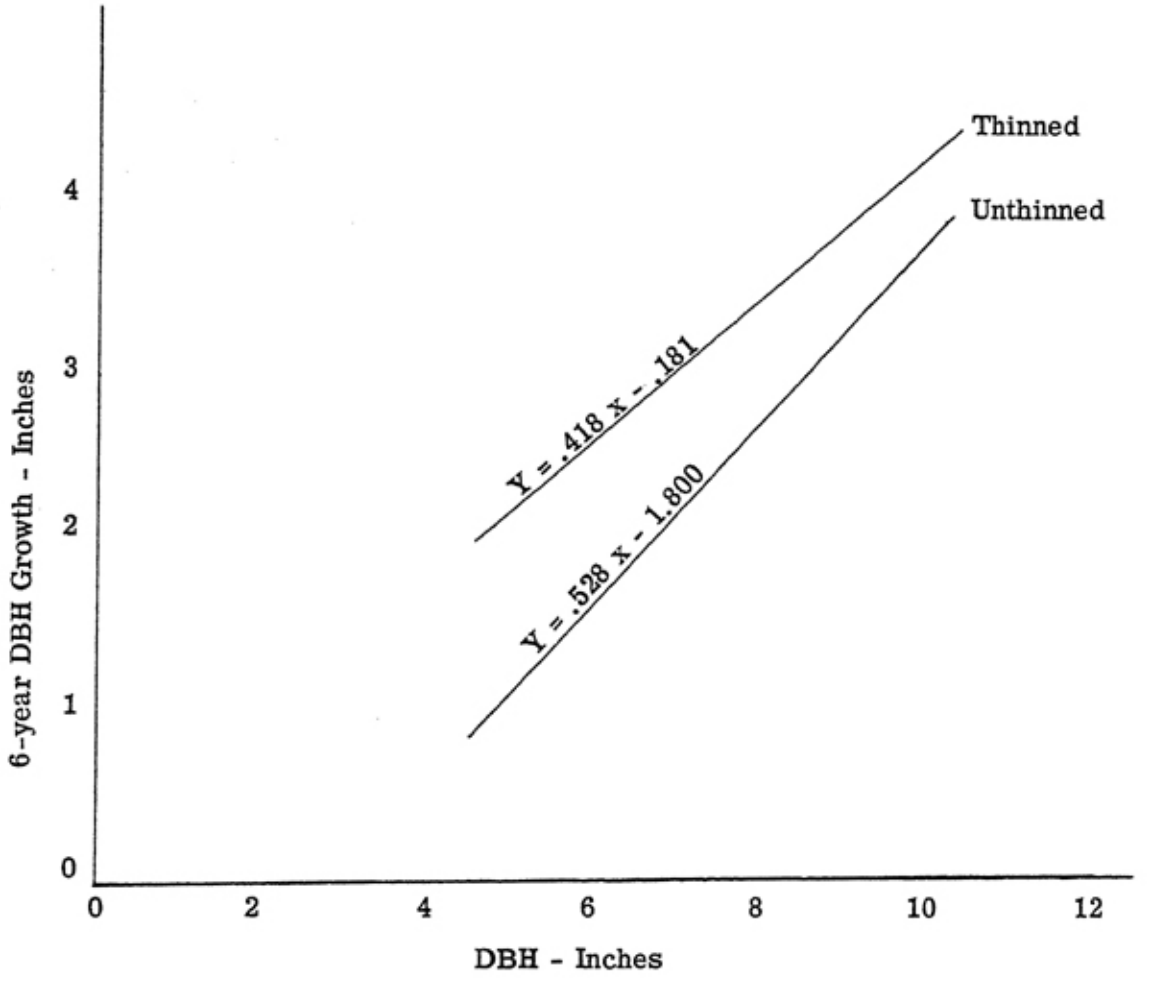

Fig. 2—Relationship between the rate of six-year diameter growth and the original diameter at breast height for the cottonwood plantation.

TABLE 2--RELATIONSHIP OF SIX-YEAR DIAMETER GROWTH BY DIAMETER CLASSES OF THE THINNED AND UNTHINNED PLOTS IN THE COTTONWOOD PLANTATION

DBH Class (Inches)	Diameter Growth		Significant difference in growth
	Thinned Plots (Inches)	Unthinned Plots (Inches)	
5	2.4	1.4	*
6	2.0	1.5	*
7	2.6	2.2	*
8	3.1	2.7	*
9	3.7	3.6	
10	3.6	3.2	

* Significant at the 5% level.

The relationship between six-year diameter growth and the original diameter was calculated and plotted for both the thinned and unthinned plots (Figure 2). The difference in the rate of diameter growth of trees between the thinned and unthinned plots decreased as the original diameter of the trees increased. For example, trees averaging 6, 8, and 10 inches d.b.h. on the thinned plots grew 2.3, 3.1, and 4.0 inches in diameter, respectively. On the unthinned plots these same diameter classes grew 1.4, 2.4, and 3.5 inches. Thus the difference in average diameter growth ranged from 0.9 inch for the 6-inch trees to 0.5 inch for the 10-inch trees.

Natural Stand, Block I. The average six-year diameter growth on the heavily thinned, lightly thinned, and check plots was 1.7, 1.6, and 1.2 inches, respectively. Trees on these plots now average 6.1, 7.3, and 5.7 inches respectively.

The relationship between six-year diameter growth and the original diameter was calculated and plotted for the heavily thinned, lightly thinned, and check plots (Figure 3). Diameter growth of 7-inch trees on these plots averaged 2.7, 2.4, and 2.0 inches, respectively. Diameter growth of trees on the heavily thinned

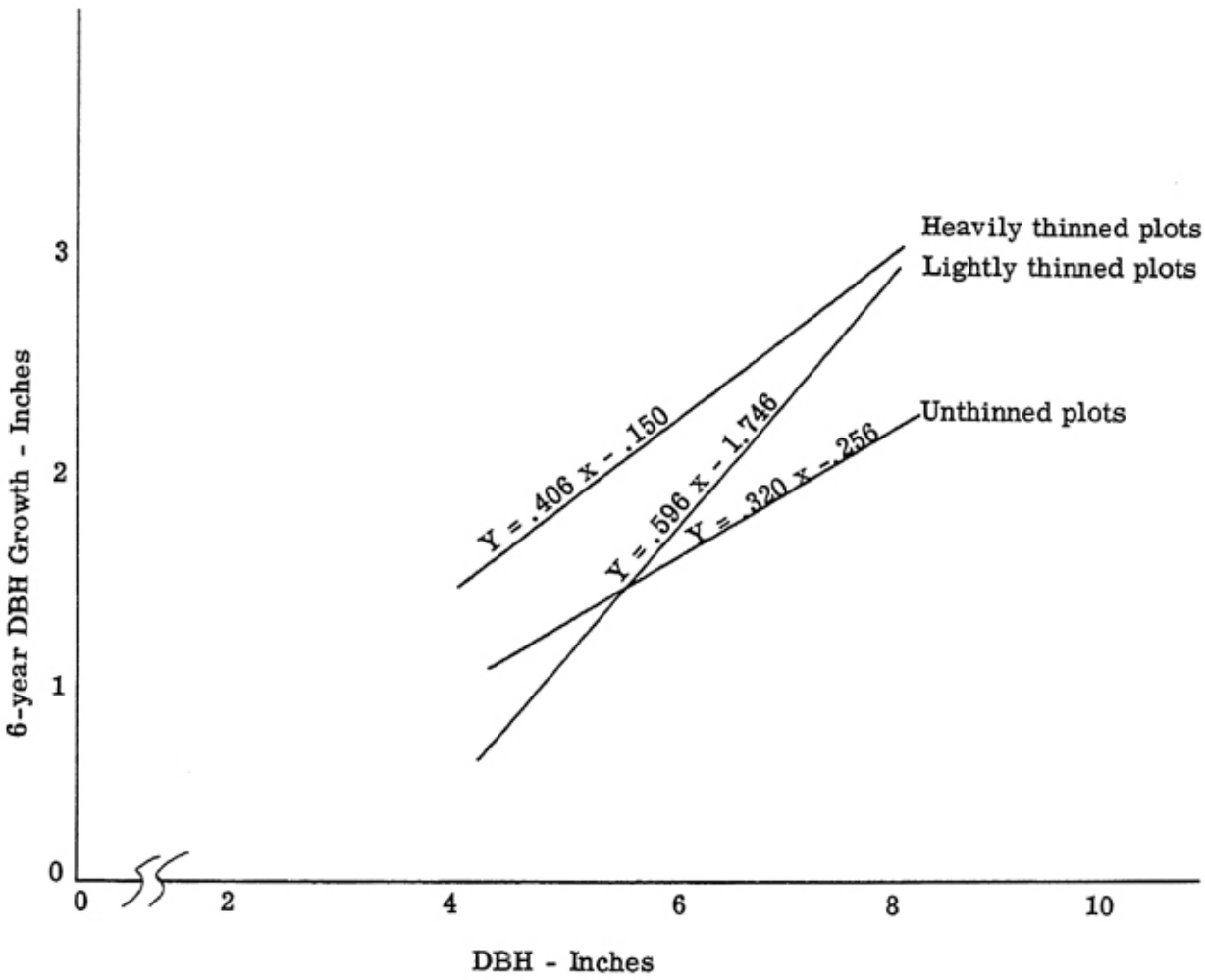

Fig. 3—Relationship between the rate of six-year diameter growth and the original diameter at breast height for Block I, Weldon Spring.

plots of this block was about the same as growth of trees on the thinned plots in the plantation.

Comparisons of diameter growth by diameter classes were not made because of too few trees in most of the 1-inch diameter classes.

Natural Stand, Block II. The average three-year diameter growth on the thinned and unthinned plots was 0.8 and 0.5 inches as the trees grew to an average of 4.5 and 4.1 inches, respectively.

The relationship between three-year diameter growth and the original diameter was calculated and plotted for the thinned and unthinned stands. The rate of diameter growth of trees was about 0.2 inches more on the thinned plots than on the unthinned (Figure 4).

Comparisons of diameter growth by diameter classes failed to show any consistent differences between the thinned and unthinned plots.

Only three years of growth were available as these plots were burned during the fourth growing season. Most of the cottonwood trees were killed by the fire.

Number of Trees Per Acre

Plantation. The plantation was planted at the rate of 726 trees per acre. Before treatment at eight years of age, there were 375 trees per acre on the unthinned plots and 385 on the thinned plots (Table 3). The thinned plots were thinned to 190 trees per acre. An additional 10 trees died during the six-year period. Half of these trees were blown down during a tornado which passed over the plots after the third growing season. On the unthinned plots mortality reduced the stocking to 232 trees per acre. Thus, the number of trees per acre on the un-

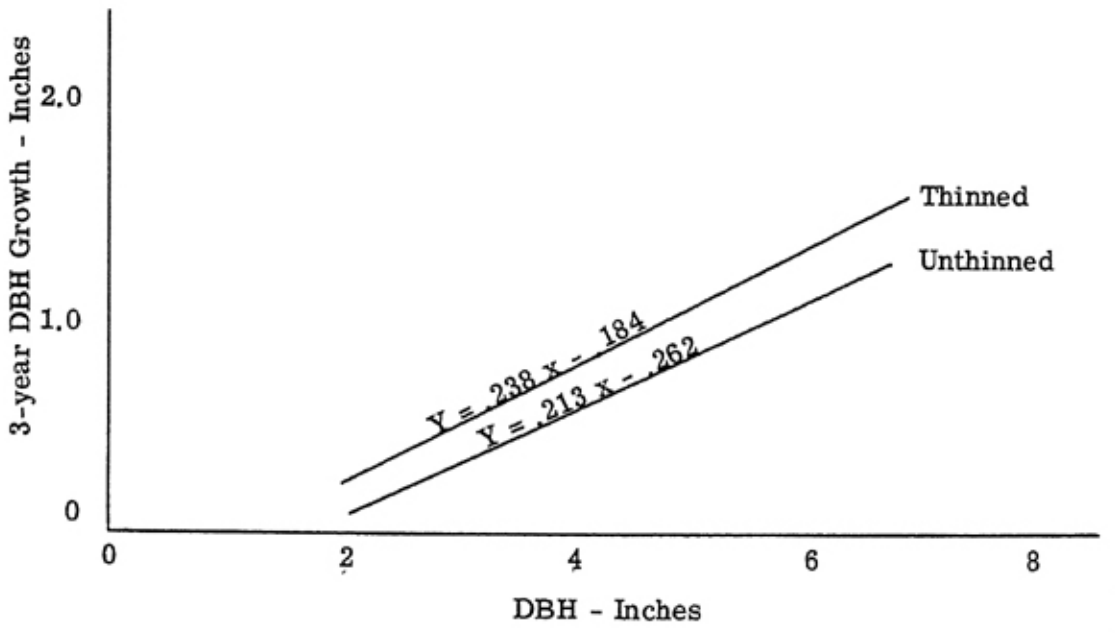

Fig. 4—Relationship between the rate of three-year diameter growth and the original diameter at breast height for Block II, Weldon Spring.

TABLE 3--STAND TABLE FOR THE COTTONWOOD PLOTS IN THE PLANTATION AT THE DuPONT STATE FOREST, ASHBURN, MISSOURI

Age (Years)	Number of Trees Per Acre													Avg. DBH (inch)	MAI (inch)
	Total	DBH Class - Inches													
		2	3	4	5	6	7	8	9	10	11	12	13	14	
Average of thinned plots															
8 1/	385	10	17	28	80	60	100	55	25	10	0	0	0	0	6.18	.772
8 2/	190	0	0	0	18	28	72	42	22	8	0	0	0	0	7.26	.908
14	180	0	0	0	0	2	13	20	45	32	28	25	10	5	10.04	.717
Mortality 3/	10	0	0	0	3	0	2	2	0	3	0	0	0	0	--	--
Average of unthinned plots															
8 1/	375	22	45	32	58	72	65	48	25	8	0	0	0	0	5.69	.711
14	232	0	2	0	12	15	40	35	38	40	20	13	12	5	8.94	.639
Mortality 3/	143	20	45	20	30	15	5	8	0	0	0	0	0	0	--	--

1/ Before thinning.
2/ After thinning.
3/ Number of trees per acre that died during the study.

Fig. 5—A natural stand of cottonwood and willow after eight growing seasons, Plot 1 of Block I, Weldon Spring before thinning. A large number of Cottonwood and Willow saplings are already dead and down.

thinned plots is approaching that of the thinned plots. Average spacing for trees on the thinned plots is now 15.6 x 15.6 feet and that on the unthinned, 13.7 x 13.7 feet.

On the unthinned plots mortality was primarily in the smaller trees. Eighty-one percent of the mortality during the study consisted of trees 5 inches or less in diameter. Trees that were 5 inches or less in diameter at the start of the sudy grew an average of 1.4 inches during the six-year period. This was much less than the 2.1-inch average for the unthinned plots. Comparable trees on the thinned plots averaged 2.4 inches during the six-year period.

Before treatment, trees on the thinned and unthinned plots approached a normal frequency distribution by diameter classes. Thinning affected the normal distribution on the thinned plots by skewing the distribution toward the larger diameters. However, after six years the diameter distribution of the thinned plots is again approaching a normal frequency distribution. The unthinned plots have approached a normal frequency distribution throughout the study.

Natural Stand, Block I. At the start of the study there were 1600 cottonwood and 184 black willow (*Salix nigra* Marsh.) trees per acre on the plots, making a total of 1784 live stems per acre (Table 4). Prior to thinning there were also 1528 dead trees per acre still standing. This means that at one time the stand had a minimum of 3312 trees per acre. In addition, there were many dead trees that had already fallen over (Figures 5-7).

Fig. 6—Plot 1 of Block I at Weldon Spring with all dead trees, largely willow, removed. Basal area was 104.04 square feet per acre.

Fig. 7—Plot 1 of Block I at Weldon Spring thinned to a basal area of 51.12 square feet per acre.

TABLE 4--STAND TABLE FOR THE COTTONWOOD PLOTS IN BLOCK I, WELDON SPRING, MISSOURI

Age (Years)	Total	Number of Trees Per Acre, DBH Class - Inches: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Avg. DBH (inch)	MAI (inch)
Heavily thinned plots 1/																	
8 2/	1760	160	740	360	280	100	60	40	0	0	20	0	0	0	0	2.93	.366
8 3/	420	0	0	120	180	40	20	40	0	0	20	0	0	0	0	4.46	.558
14	420	0	0	0	80	120	80	60	40	20	0	0	0	0	20	6.12	.437
Mortality 4/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
Lightly thinned plots 5/																	
8 2/	1160	20	200	440	160	140	100	60	20	0	20	0	0	0	0	3.78	.472
8 3/	600	0	20	200	100	120	80	40	20	0	20	0	0	0	0	4.64	.580
14	360	0	0	20	0	100	40	60	60	0	60	0	0	0	20	7.29	.521
Mortality 4/	240	0	20	180	40	0	0	0	0	0	0	0	0	0	0	--	--
Unthinned plots 6/																	
8 2/	2160	440	680	520	240	80	80	40	80	0	0	0	0	0	0	2.88	.360
14	720	0	0	40	280	120	80	0	80	40	80	0	0	0	0	5.71	.408
Mortality 4/	440	440	680	200	120	0	0	0	0	0	0	0	0	0	0	--	--

1/ Heavily thinned plots contained no live willow.
2/ Before thinning.
3/ After thinning.
4/ Number of trees per acre that died during study.
5/ Lightly thinned plot contained 180 willow per acre before thinning. All willow was cut in the thinning.
6/ Unthinned plots also contained willow at the rate of 560 trees per acre which died during the first 2 years following treatment.

TABLE 5--STAND TABLE FOR THE COTTONWOOD PLOTS OF BLOCK II, WELDON SPRING, MISSOURI

Age (Years)	Number of Trees Per Acre										Avg. DBH (inch)	MAI (inch)
	Total	DBH Class - Inches										
		1	2	3	4	5	6	7	8	9		
Average of thinned plots 1/												
8 2/	1840	386	613	466	174	134	40	27	0	0	2.53	.316
8 3/	800	13	173	293	147	107	40	27	0	0	3.34	.418
11	600	0	27	187	133	93	80	27	53	0	4.48	.407
Mortality 4/	200	13	106	67	14	0	0	0	0	0	--	--
Average of unthinned plots 5/												
8 2/	2100	540	700	480	220	40	80	40	0	0	2.42	.302
11	840	0	60	280	320	40	20	100	0	20	4.11	.374
Mortality 4/	1260	540	600	120	0	0	0	0	0	0	--	--

1/ Thinned plots also contained 853 willow per acre. All willow was cut during thinning.
2/ Before thinning.
3/ After thinning.
4/ Number of trees per acre that died during the study.
5/ Unthinned plots also contained 260 willow per acre. All willow died during the first three years following treatment.

After being thinned, the heavily thinned plots contained 420 trees and the lightly thinned plots, 600 trees per acre, respectively. After the six-year study period the heavily thinned and lightly thinned plots had 420 and 360 trees per acre, respectively. Corresponding spacings were 10.2 x 10.2 and 11.0 x 11.0 feet. After the six-year study period the unthinned plots had 720 trees per acre, with an average spacing of 7.8 x 7.8 feet.

The average diameter of trees on the unthinned plot was 2.88 inches. All of the trees in the 1 and 2-inch class and 40 percent of the trees in the 3-inch class died during the study. Thus 80 percent of the mortality during the study was in trees of average diameter or less.

Natural Stand, Block II. At eight years of age there were 1752 cottonwood and 736 black willow trees per acre making a total of 2488 live trees per acre (Table 5). In addition, there were 1768 dead trees per acre. Thus part density in terms of number of trees per acre was 4256. The average maximum spacing at that time was 3.2 x 3.2 feet.

On the unthinned plots, 73 percent of the trees 3 inches or less in diameter died during the three-year study period. During the same period the number of trees per acre on the unthinned plots dropped from 2100 to 840 trees per acre. During the same time the thinned plots dropped from 800 to 600 trees per acre.

Basal Area Growth

Plantation. Basal area* growth was greater on the thinned plots than on the unthinned (Table 6). During the study the thinned plots increased from an

TABLE 6--AVERAGE BASAL AREA PER ACRE AT DIFFERENT AGES FOR THE THINNED AND UNTHINNED PLOTS IN THE COTTONWOOD PLANTATION.

Age (years)	Treatment	
	Thinned (sq. ft.)	Unthinned (sq. ft.)
8 1/	85.8	74.9
8 2/	56.7	74.9
9	66.2	84.8
10	76.7	94.9
11	84.6	100.4
12	92.6	104.0
13	96.3	105.8
14	102.1	107.8
6-year growth	45.4	32.9

1/ Before thinning.
2/ After thinning.

average basal area of 57 square feet per acre to 102 square feet per acre for an increase of 45 square feet. In the same period the unthinned plots increased in basal area from 75 to 108 square feet per acre for an increase of 33 square feet.

*Basal area and basal area growth are based upon d.b.h. measurements, outside bark.

The highest basal area observed on an unthinned plot was 141 square feet per acre at 14 years of age.

During the first two years of this study the basal area of both the thinned and unthinned plots increased at the rate of 10 square feet per acre per year. During the second two years the thinned plots increased at a rate of 8 square feet per acre per year compared with only 5 square feet per acre per year on the unthinned plots. During the last two years the thinned plots increased in basal area at the rate of 5 square feet and the unthinned at a rate of 2 square feet per acre per year.

Natural Stand, Block I. Basal area growth was the greatest on the heavily thinned plots, second greatest on the lightly thinned plots, and the least on the unthinned plot (Table 7). During the six-year period the heavily thinned, lightly thinned, and unthinned plots increased an average of 47, 37, and 17 square feet per acre, respectively. The highest basal area observed was on the unthinned plot which had a basal area of 149 square feet per acre at 14 years of age.

TABLE 7--AVERAGE BASAL AREA PER ACRE AT DIFFERENT AGES FOR THE HEAVILY THINNED, LIGHTLY THINNED, AND UNTHINNED PLOTS IN BLOCK I OF THE NATURAL STAND

Age	Treatment		
	Heavily thinned	Lightly thinned	Unthinned
(Years)	(sq. ft.)	(sq. ft.)	(sq. ft.)
8 1/	104.2	106.1 3/	131.8 3/
8 2/	51.4	80.7	131.8 3/
9	59.6	87.2	140.2
10	65.2	87.8	129.7
11	73.4	91.6	130.0
12	81.7	99.8	133.4
13	88.9	107.5	138.4
14	98.1	117.5	149.1
6-year growth	+46.7	+36.8	+17.3

1/ Before thinning.
2/ After thinning.
3/ These figures do not include the basal area of willow present on the plots. This was 4.6 square feet on the lightly thinned and 5.6 feet on the unthinned. No willow was on the heavily thinned plots.

Natural Stand, Block II. During the three years of study the thinned plots increased 16 square feet in basal area from an original thinned basal area of 56 square feet per acre (Table 8). During the same period, the unthinned plots increased from 87 to 88 square feet, an average increase of only 1 square foot per acre. Mortality was very heavy on the unthinned plots of this stand and was largely responsible for this small increase in basal area.

TABLE 8--AVERAGE BASAL AREA PER ACRE AT DIFFERENT AGES FOR THE THINNED AND UNTHINNED PLOTS OF BLOCK II IN THE NATURAL STAND.

Age (years)	Treatment: Thinned (sq. ft.)	Treatment: Unthinned (sq. ft.)
8 1/	79.4 3/	87.2 3/
8 2/	56.5	87.2 3/
9	64.7	90.5
10	67.8	85.7
11	72.2	88.0
3-year growth	15.7	0.8

1/ Before thinning.
2/ After thinning.
3/ These figures do not include the basal area of willow present on the plots. This was 19.6 square feet on the thinned and 5.3 feet on the unthinned.

Volume Growth

Plantation. Thinning has increased the average volume growth of individual trees. The average volume per acre increase was about the same for both the thinned and unthinned plots. In the six-year study period the average volume increase** for the thinned and unthinned plots was 1551 and 1458 cubic feet per acre. At 14 years of age they averaged 2596 and 2685 cubic feet per acre, respectively (Table 9).

TABLE 9--AVERAGE CUBIC-FOOT VOLUME PER ACRE BY DIAMETER CLASSES ON THE THINNED AND UNTHINNED PLOTS OF THE PLANTATION

DBH Class	Age: 8 Years: Thinned 1/	Age: 8 Years: Unthinned	Age: 14 Years: Thinned	Age: 14 Years: Unthinned
(inches)	(cu. ft.)	(cu. ft.)	(cu. ft.)	(cu. ft.)
4	15	49	0	0
6	228	432	70	187
8	603	481	304	614
10	199	265	1042	898
12	0	0	817	627
14	0	0	363	359
Total	1045	1227	2596	2685

1/ An average of 395 cubic feet per acre was removed from the thinned plots and is not included. Only trees 4.0 inches and larger are included.

At eight years of age the thinned and unthinned plots had about the same volume per acre in trees that were of average diameter or better. At 14 years of age and considering trees in the 10-inch class and up, the thinned plots had 300 cubic feet per acre more than was present on the unthinned plots.

**Cubic-foot volume of the trees in the plots was based upon Table 14, E. N. Munns and R. M. Brown, 1925. Volume tables for the important timber trees of the United States. U.S.D.A. Forest Service, Part III, p. 25. The table was based on trees from Arkansas, Kentucky, Tennessee, Missouri, Mississippi, and Louisiana.

Natural Stand, Block I. The volume growth of the trees in this block varied only slightly with treatment. The heavily thinned plots increased 1640 cubic feet to a total of 2178 cubic feet per acre (Table 10). The lightly thinned plots increased 1574 cubic feet to a total of 2552 cubic feet per acre. The unthinned plot increased 1802 cubic feet to a total of 2936 cubic feet per acre. The difference in diameter distribution within plots of the different treatments was responsible for some of the variation in the growth. On the lightly thinned plots 40 percent of the trees left after thinning died during the study. Most of these were in the smaller diameter classes.

Natural Stand, Block II. The volume growth of these plots was about the same for both treatments. The thinned and unthinned plots increased 662 and 633 cubic feet to a total of 1078 and 1102 cubic feet per acre (Table 11). These volumes cannot be compared with Block I of the natural stand or with the plantation since they are based on only three years growth to age 11 years.

Relationship of Height, Diameter, and Age

The relationship of total height and diameter at breast height at different ages was calculated (Figure 8). The data from the plantation and natural stand

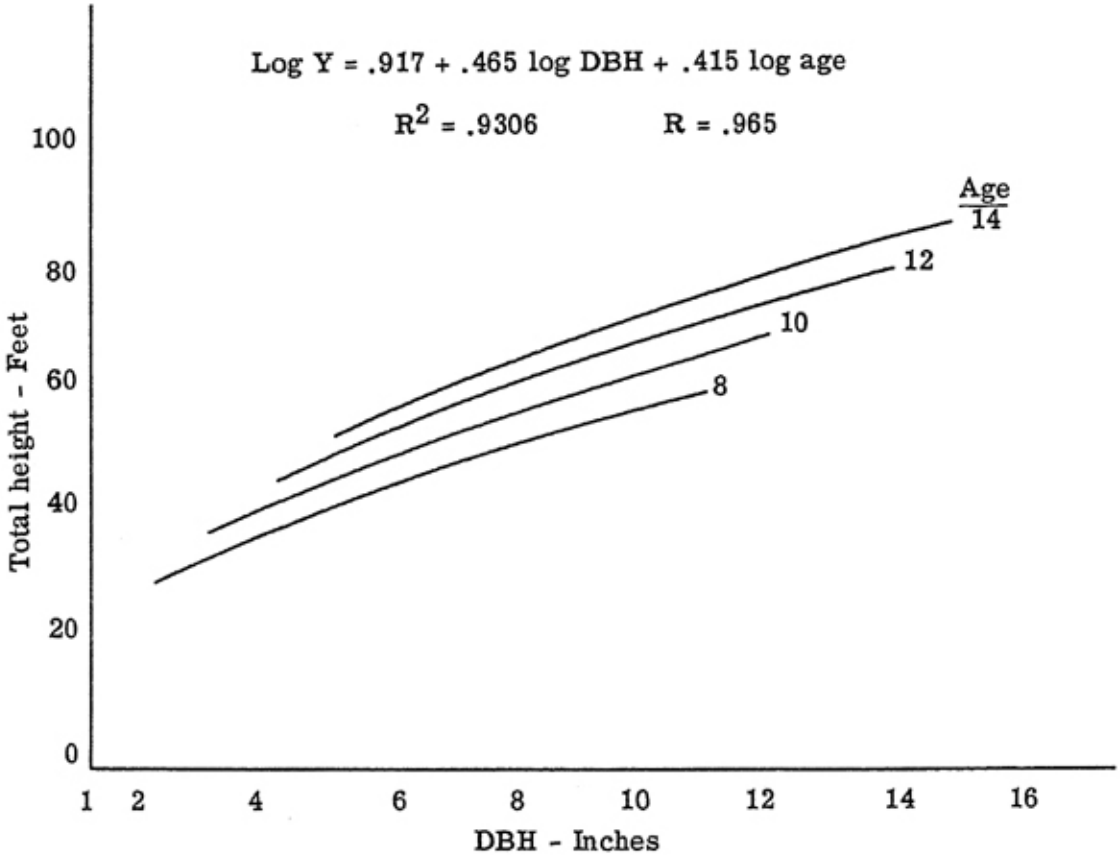

Fig. 8—Relationship of total height to diameter at breast height of trees at different ages.

TABLE 10--AVERAGE CUBIC-FOOT VOLUME PER ACRE BY DIAMETER CLASSES ON THE PLOTS IN BLOCK I OF THE NATURAL STAND

DBH Class (Inches)	Age					
	8 Years			14 Years		
	Heavily thinned (cu. ft.) 1/	Lightly thinned (cu. ft.) 1/	Unthinned (cu. ft.)	Heavily thinned (cu. ft.)	Lightly thinned (cu. ft.)	Unthinned (cu. ft.)
4	106	88	84	123	42	248
6	214	398	296	624	383	457
8	0	323	754	575	887	670
10	218	229	0	218	586	1561
12	0	0	0	0	0	0
14	0	0	0	638	654	0
Total	538	1038	1134	2178	2552	2936

1/ An average of 15 and 8 cubic feet per acre was removed from the heavily thinned and lightly thinned plots which are not included. Only trees 4.0 inches and larger are included.

TABLE 11--AVERAGE CUBIC-FOOT VOLUME PER ACRE BY DIAMETER CLASSES ON THE PLOTS IN BLOCK II OF THE NATURAL STAND

DBH Class (inches)	Age			
	8 Years		11 Years	
	Thinned 1/ (cu. ft.)	Unthinned (cu. ft.)	Thinned (cu. ft.)	Unthinned (cu. ft.)
4	92	36	140	222
6	260	337	493	259
8	64	96	445	621
Total	416	469	1078	1102

1/ An average of 18 cubic feet per acre was removed from the thinned plots which is not included. Only trees 4.0 inches and larger are included.

were combined since no difference was found between the total heights of trees of the same diameter for the two areas.

The average height of an eight-inch tree that is eight years old is 52 feet while at 12 years an eight-inch tree would be 61 feet. Thus within the limits of the sample the heights of cottonwood trees can be predicted if the diameter and age are known.

Persistence of Branches

The number of branches and their persistence has been a problem in the plantation. At 14 years of age on the thinned plots there was an average of 0.6 live branches and 9.7 dead branches per tree on the first 17 feet of the bole. On the unthinned plots there was an average of 1.2 live branches and 10.9 dead branches. Thus there is no real difference between trees on the thinned and unthinned plots. Pruning is essential to obtain maximum volume in logs suitable for high quality lumber and veneer.

In the natural stand there are very few branches in the first 17 feet and pruning would probably not be necessary. The lack of branches is more than likely due to the branches dying while they are smaller and being knocked off by dead trees as they fell.

IMPLICATIONS AND RECOMMENDATIONS

Individual trees of young cottonwood stands will respond to thinning when the basal area is reduced by thinning to 50 to 60 square feet per acre. A lighter thinning to about 80 square feet per acre does not increase the diameter growth as much as the heavier thinning. To maintain this accelerated diameter growth stands should be rethinned as the basal area approaches 100 square feet per acre.

In plantations, individual crop trees should be pruned to get the maximum amount of clear wood. If not pruned, branches will persist for many years. In natural stands pruning is not as essential, particularly when the stands were very dense in the earlier ages.