POPULATION STUDIES OF *ULMUS CRASSIFOLIA* IN FLOOD PLAIN FORESTS OF DENTON COUNTY, TEXAS

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

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August, 1974

Koch, Linda S., Population Studies of *Ulmus crassifolia* in Flood Plain Forests of Denton County, Texas. Master of Arts, Biology, August, 1974, 100 pp., 16 tables, 14 figures, bibliography, 10 titles.

The problem with which this investigation was concerned was the comparison of cedar elm populations in different stands along creeks in Denton County, Texas, and the relationship of certain population parameters to various substrates present at stand sites. Parameters investigated included average basal area, basal-area density, transect-segment density, intertree distance, lateral distance, frequency, diameter breast-high, diameter breast-high size-class distribution, and immature-tree density.

Variations among populations of *Ulmus crassifolia* Nutt. were noted and analyzed in terms of soil particle size and existing community conditions.

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CHAPTER I

INTRODUCTION

Ulmus crassifolia Nutt., cedar elm, is found with high frequency in floodplain forests in Denton County, Texas. The tree attains a maximum height of thirty meters and has a narrow or rounded crown. Leaves are simple, alternate, short-petioled, acute or obtuse at apex, rounded to oblique at the base, and have doubly serrate margins (Fig. 1). The leaves

Fig. 1--Leaf arrangement of cedar elm twig

are dark green, stiff, rough above and pubescent beneath. The brown, reddish, or gray bark appears as flattened redges broken into thin, loose scales. Cedar elm is found on limestone soils and floodplains ranging through northern Mexico, Texas, Oklahoma, Arkansas, Louisiana, and Mississippi (3). One isolated occurrence is reported from Suwanee County, Florida (1).

Although past observations indicated that cedar elm was a major component of floodplain forests in Denton County, few references concerning cedar elm are found in the literature. Rice and Penfound (2) found *Ulmus crassifolia* to be a species of minor importance in central and eastern Oklahoma upland forest stands, and Tharp (4) noted cedar elm to be among the larger trees in the burr oak-pecan-cedar elm hardwood tree associes of the San Antonio River bottomlands.

The purpose of this study was to compare cedar elm populations in different stands along creeks in Denton County, Texas, and to relate certain population parameters to various substrates present at stand sites. Parameters investigated included average-basal area, basal-area density, transect-segment density, intertree distance, lateral distance, frequency, diameter breast-high, diameter breast-high size-class distribution, and immature-tree density. Variations among populations of cedar elm were noted and analyzed in terms of soil types and existing community conditions.

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CHAPTER II

METHODOLOGY

Choosing Stands

Stands were located through use of aerial photographs, geological and highway maps, and field reconnaissance. Accessibility, stand size, and lack of disturbance were determining factors in choosing stands on each creek. Each stand had to be large enough to allow sampling by means of line transects through areas relatively free of ecotone effect or extensive disturbance. At least two stands per creek were needed to compare populations in stands along the same creek.

Through field reconnaissance, all accessible stands were examined for disturbance and ecotone effect. The majority of existing stands proved unsuitable for inclusion in the study. Hickory Creek and Pecan Creek stands were excluded due to the paucity, small size, and extensive clearing and destruction of forestland along these creeks.

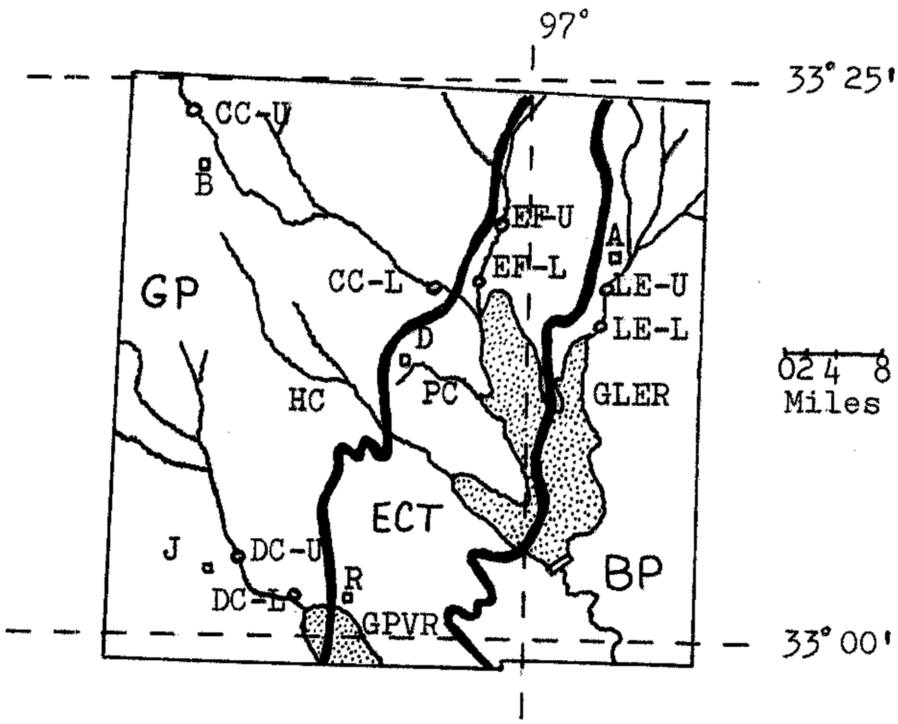
Some of the larger Denton Creek stands have undergone cutting or clearing for use as cropland or sand and gravel pits. One of the larger stands of streamside forest was destroyed by the interstate-highway-I-35W-bridge construction over Denton Creek. Other existing Denton Creek forest stands have been under the stress of heavy cattle grazing. For many years the understory of each of these stands has been sporadically cut, cleared, and burned, leaving a few large trees in a floodplain pastureland.

Most stands along Clear Creek have recently been cut or cleared for farming and for the construction of flood-control reservoirs. One Clear Creek stand five miles north of Denton was of adequate size for sampling but was excluded from this study after reconnissance proved the stand to be dissected by gulleys and a road. The stand also showed strong ecotone effects of a mixed presence of streamside flora and flora from nearby upland-forest slopes.

In past years, many Elm Fork stands were almost entirely removed to allow cultivation of the rich streamside soils. Several stands of bottomland forest remain along the Elm Fork above its confluence with Clear Creek. Most, however, exhibit evidences of extensive grazing or ecotone effect.

The construction and subsequent filling of Garza-Little Elm Reservoir inundated and reduced much of the lower flood plain forest of Little Elm Creek. Many of the remaining stands are relatively small strips of trees that border the creekbanks, and are surrounded by fields of cotton and grain. Extensive farming pressures have caused clearing of nearly all sites suitable for inclusion in this study.

Two stands, designated as upper and lower stands, were sampled along each of four major creeks in Denton County, Texas (Fig. 2).



Vegetation belts

GP: Grand Prairie
ECT: Eastern Cross Timbers
BP: Blackland Prairie

Reservoirs

GLER: Garza-Little Elm
GPVR: Grapevine

Towns

A: Aubrey
B: Bolivar
D: Denton
J: Justin
R: Roanoke

Stands/Creeks

U: Upper Stand
L: Lower Stand
CC: Clear Creek
DC: Denton Creek
EF: Elm Fork
HC: Hickory Creek
LE: Little Elm
PC: Pecan Creek

Fig. 2--Generalized map of Denton County, Texas, showing vegetation belts, reservoirs, creeks, towns, and stands (3).

Choosing Transects

Cedar elm trees with a dbh (diameter breast-high) of 1.5 inches or more were designated mature trees and sampled using the crown-intercept-line-transect method (2). Stand size was the determining factor in establishing the number of transects at each study site. Two transects were run at each stand, as this number was the maximum number of transects that could be run without overlap or ecotone interference at the smallest study site. The minimum transect length was arbitrarily set as 250 meters, but was extended where variations in environment, tree density, and tree size indicated a local difference in vegetation. All transects were continued beyond the minimum length to increase sample size and obtain a more representative sample of the cedar elm population found within a given stand.

Each transect was laid out from a designated base point chosen such that the beginning of each transect would be well within the stand, free of ecotone effect, and could be easily relocated. Base points were marked with bright orange or red paint, and transect trees were marked with blue or dull-red paint. Where possible, transects followed predetermined degree headings of a pocket compass accurate to five degrees. In some stands, transect-compass headings intersected ecotones, areas of severe disturbance, or natural boundaries. In other stands, nearly impenetrable undergrowth rendered compass headings difficult to follow. In such cases, transect-degree headings were either changed near the point of disturbance or laid parallel to and beyond the ecotone area, stand boundary, or creekbank.

Crown-Intercept Sampling of Mature Trees

Mature cedar elm trees whose crowns intercepted transect lines were measured to the nearest 0.1 inch diameter with a standard dbh tape and marked for identification and relocation with blue or red paint. For each cedar elm, lateral distance and intertree distance were recorded to the nearest 0.5 meter. Distances were estimated by carefully pacing as close to a one-meter length as possible and counting the number of paces between points. Lateral distance was measured as the perpendicular distance from the transect line to the bole of the crown-intercept tree. The distance along the transect line and between two successive points where lateral-distance lines intersected the transect was designated intertree distance. Location of each crown-intercept tree along the transect was recorded to the nearest 0.5 meter. Total transect length was divided into ten-meter segments, and the transect-segment density (number of trees per each ten-meter transect-segment) and frequency (per cent occurrence in total number of ten-meter transect-segments per transect) were recorded.

Quadrat Sampling of Immature Trees

An estimate of reproductive success of cedar elm trees was obtained by sampling immature trees at each site. Immature cedar elm trees (those with a diameter smaller than 1.5 inches dbh) were sampled by the use of quadrats. One transect at each study site was divided into ten, equal lengths. A ten- by ten-meter quadrat was established at the beginning and to the right or left (determined by a coin toss) of each transect-length such that the transect formed one side of the quadrat. In each quadrat, cedar elm trees with a diameter breast-high of less than 1.5 inches were counted and recorded as immature trees.

Mechanical Analysis of Soils

In order to relate population parameters to substrate type, soil samples were collected at the midpoint of one transect at each site. After removal of surface debris, one sample of the upper 1-5 inch A_1-topsoil layer and one sample of the deeper, 6-12 inch B_1 layer were collected. Samples were oven dried for 48 hours at 110° C. Mechanical analysis of soil texture of samples was by the hydrometer method (1). Per cent composition of sand, silt, and clay was determined for the A_1 and B_1 layer of each stand.

Statistical Treatment of Data

Statistical analyses and comparison of population parameters data were done by computer at the Merrick Computing Center of the University of Oklahoma. Minimum, mean, maximum, standard deviation, standard error, degrees of freedom, and t were determined and compared for diameter breast-high, inter-tree distance, lateral distance, transect-segment density, and immature-tree density. So that some estimate of age-class distribution could be gained, dbh data were grouped into the following 5 size-classes: size-class A (1.5-4.0 inches), size-class B (4.1-8.0 inches), size-class C (8.1-12.0 inches), size-class D (12.1-16.0 inches), and size-class E (16.1 inches or larger). Per cent composition of each size-class was determined and compared for each stand. Frequency (per cent transect-segments occupied by cedar elm trees) was calculated and compared at both stand and creek levels. Basal area per tree, $(\frac{1}{2}\ \text{dbh})^2$, was calculated and average basal area per tree determined and compared for each stand and creek. Basal-area density (total basal area of trees divided by the total-meters-transect length) was determined at each stand and creek.

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CHAPTER III

STUDY SITES

Denton County, located in north-central Texas, is a gently rolling plain of low relief. The landscape is dissected by a number of small streams of the Trinity River watershed, and has a general slope from the northwest to the southeast (4). Three vegetational communities run north to south through the county (Fig. 2). The Blackland Prairie is a grassland covering the eastern one-fourth of the county. Upper Cretaceous deposits of Austin Chalk and Eagle Ford limestone form the underlying substrate of the grassland. The Eastern Cross Timbers is an oak-hickory-upland forest located in the northeastern, central, and south-central portions of Denton County, and overlies Cretaceous Woodbine sandstone. The western portion of the county is covered by the grassland of the Grand or Fort Worth Prairie. The limestone substrate of the Grand Prairie has its origins in the Trinity-Paluxy, Walnut, Goodland, Kiamita, Duck Creek, Fort Worth, Denton, Weno, Pawpaw, Main Street, and Grayson upper-formations of the Lower Cretaceous (1).

The climate of Denton County is classified as moist-subhumid-mesothermal by Thornthwaite (3). Normal annual-total precipitation ranges from 32 to 36 inches for the northeastern half of the county and from 28 to 32 inches in the southwestern portion. April and May are the months of highest rainfall, but rain falls throughout the growing season. The area is subject to drought. The mean length of the warm season (number of days between the mean dates of the last freeze in spring and the first freeze in the fall) ranges from 215 to 230 days. Mean-minimum temperature for January ranges from 32° F. to 36° F. Mean maximum temperature for July ranges from 96° F. to 98° F. (2).

The Lower Denton Creek Stand

The lower Denton Creek stand is located 1 mile west and 2 miles north of Roanoke (Fig. 2). The stand has an elevation of approximately 570 feet, covers 200 acres of Frio clay soils (1), and is situated at the extreme lower end of Denton Creek, just above upper Grapevine Reservoir (Fig. 3). The stand is bordered on the western fenceline by a gravel road, on the north, east, and southeast by Denton Creek, and on the southwestern fenceline by a pasture. A small, extremely northern segment of the stand has been isolated by a roadcut that runs eastward from a gravel road, through the stand, and ends at Denton Creek. The southern fenceline area is often used as a route to nearby Denton Creek fishing areas, and has been the site of considerable refuse dumping. The stand has seen limited use in past years as a local source of firewood and pecan logs. Abandoned, overgrown roads and trails wind through the stand, and the floodplain contains numerous

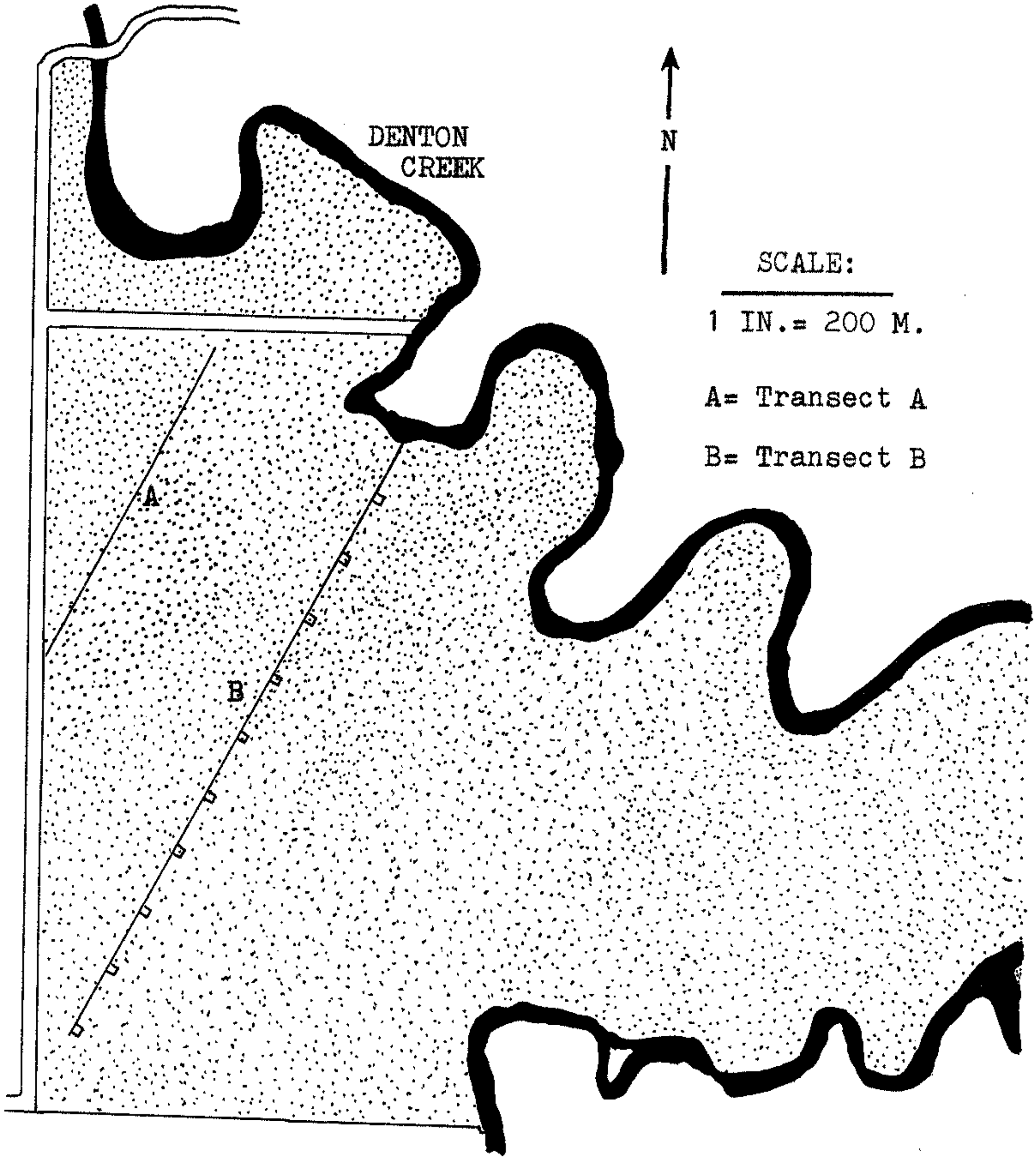

Fig. 3--The lower Denton Creek stand, showing Denton Creek, roads, transects, and quadrats.

oxbows and ephemeral pools. Occasional cattle grazing and deer browsing were observed in the stand.

Transect A was laid at 210° southwest from a sycamore tree located 150 meters east of the western edge of the stand and at the edge of an oxbow immediately south of the east-west roadcut. Transect A continued 360.5 meters south and west to near the western fenceline. Transect B was laid at 35° northeast from a cedar elm tree located approximately 20 meters east and north of the southwest corner of the stand. Transect B continued 757.5 meters through the main body of the stand, ending at Denton Creek.

The Upper Denton Creek Stand

The upper Denton Creek stand is located 0.5 miles north and 0.5 miles east of Justin (Fig. 2). The stand covers about 46 acres of Frio clay soils (1) and has an elevation of approximately 600 feet (Fig. 4). The stand is bordered on the western and southern fencelines by cultivated fields and on the north and east by Denton Creek and by the Olivers Creek tributary of Denton Creek. The southeastern portion of the stand has undergone clearing and is separated from the main body of the stand by a fenceline. This smaller portion has been used to pasture cattle and was excluded from the study. Light grazing and cattle trails are apparent throughout the main portion of the stand. Some cutting of trees for firewood use was observed in the western portion of the stand.

The basepoint of transect A was established at the center of a fenceline dividing the southeastern, cleared portion

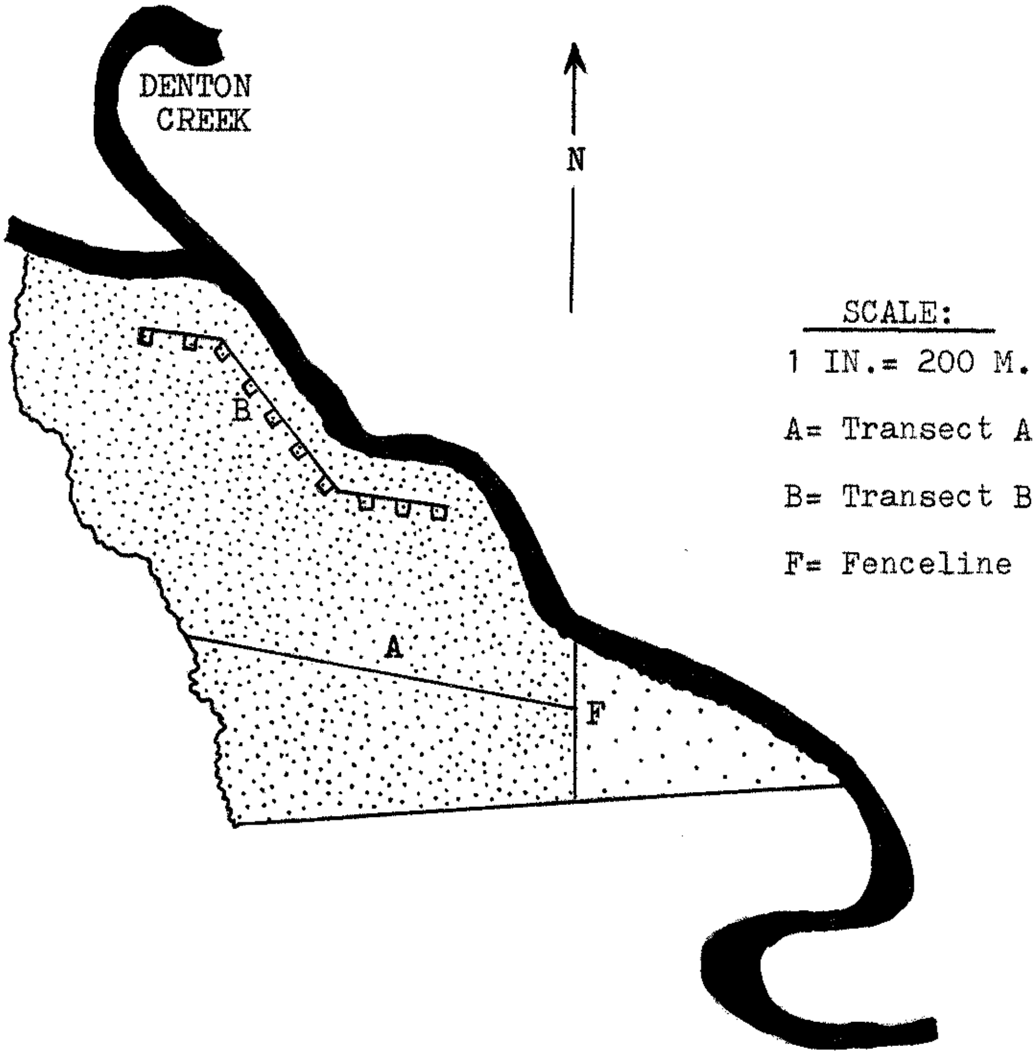

Fig. 4--The upper Denton Creek stand, showing Denton Creek, fenceline, transects, and quadrats.

from the main body of the stand. Transect A was laid at 280° west and continued 421.0 meters to near the western boundary of the stand. Transect B was laid from a large burr oak tree situated between two cattle trails at the northwest corner of the stand. Transect B continued at 95° east for 90 meters to near Denton Creek, then 310 meters roughly parallel to and 30 meters from the creek for a total transect length of 400 meters.

The Lower Clear Creek Stand

The lower Clear Creek stand is located 4.5 miles north and 0.75 miles east of Denton (Fig. 2). Clear Creek divides the stand into 3 distinct portions (Fig. 5). Small trees and underbrush have been cleared from the southwestern area, leaving several large trees in pastureland and dense thickets of greenbrier-covered trees near the creekbank. The southeastern portion is a small, narrow loop of forest subject to frequent overflow of the creek. Fallen trees in this area, washed from the soil by creek erosion, have created small clearings. Because of the extensive disturbance and heterogenous composition of these two areas, only the third, northeastern portion was selected for study. This portion covers approximately 15.5 acres, has an elevation of 560 feet, and is comprised of Frio clay soils (1). The portion of the stand under study is bordered on the northern fenceline by a drainage ditch and cultivated field, on the eastern fenceline and southeastern corner by a pasture, and on the east and south by Clear Creek. The area shows few evidences of man-made disturbances, but debris from past and recent flooding was found in trees and bushes at heights of over 4 feet. Other debris, extreme erosion of creekbank soil, and observation of the area under flooded conditions indicate frequent, destructive overflows.

Transect A was laid at 270° west from an American elm tree located 20 meters south and west of the northeast corner

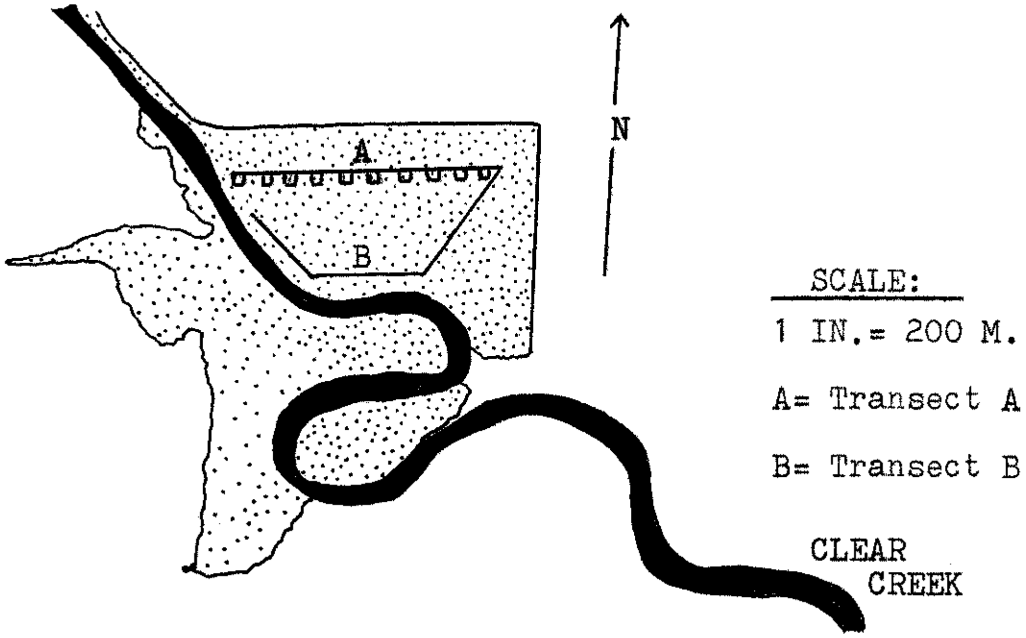

Fig. 5--The lower Clear Creek stand, showing Clear Creek, transects, and quadrats.

of the stand, and continued 275.0 meters to the creekbank of Clear Creek. Transect B was laid at 215°, heading southwest from an American elm tree located 20 meters south and west of the northeast corner of the stand. Transect B continued southwest to within 10 meters of Clear Creek, and then parallel to the creek for a total transect length of 340.0 meters.

The Upper Clear Creek Stand

The upper Clear Creek stand is located 5 miles west and 4 miles north of Bolivar (Fig. 2). The stand has an elevation of approximately 715 feet, overlies Frio clay soils in the western half of the stand and Trinity soils in the eastern and southeastern portions of the stand (1), and occupies approximately 190 acres (Fig. 6). The stand is bordered on the north by an unimproved dirt road, on the east by a cultivated

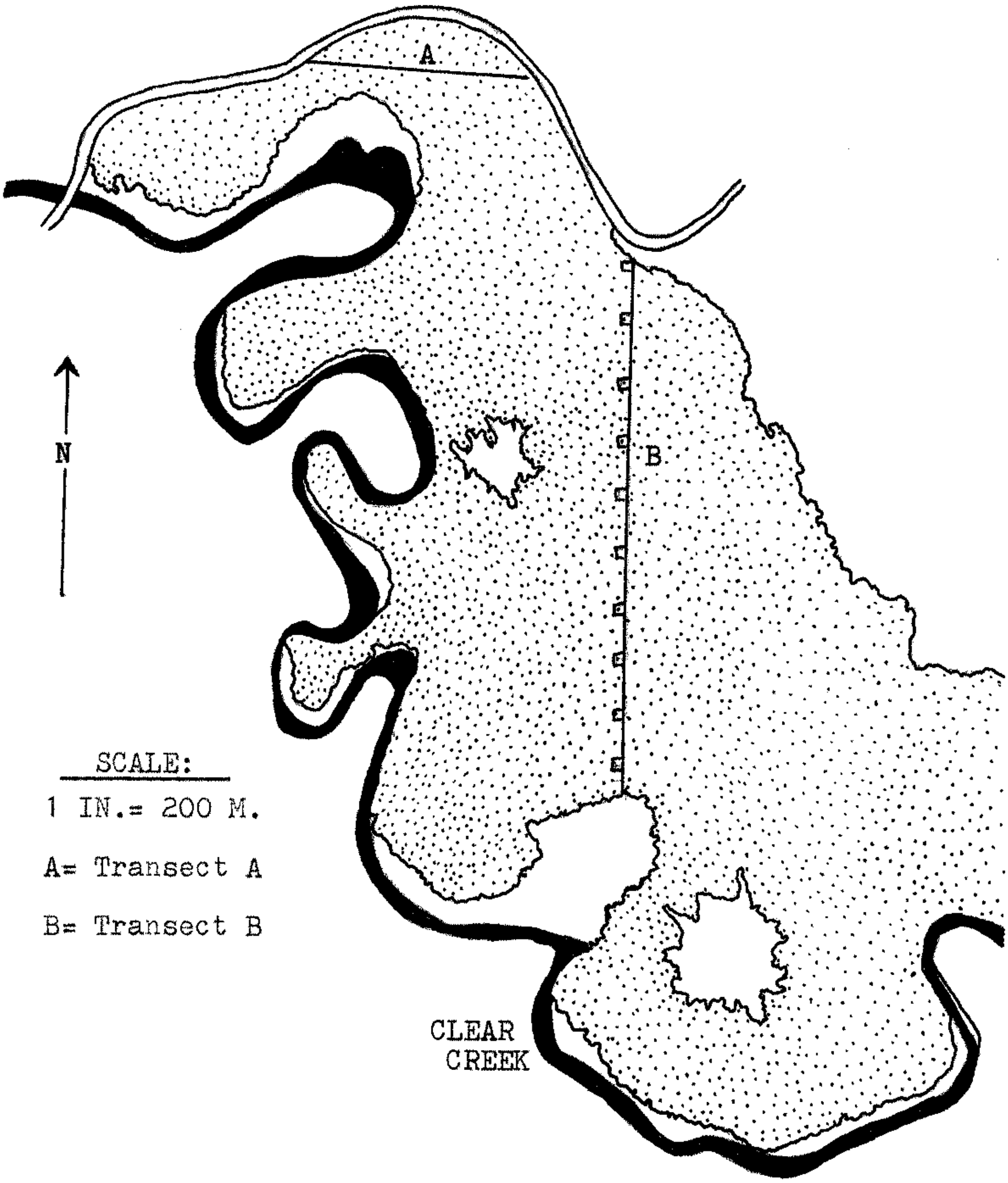

Fig. 6--The upper Clear Creek stand, showing Clear Creek, unimproved dirt road, transects, and quadrats.

field, and on the west and south by Clear Creek. The stand has undergone light grazing, but is otherwise relatively undisturbed.

Transect A was laid from an ash tree located 1 meter from the unimproved dirt road and due northwest of a large horseshoe bend of Clear Creek. Transect A continued east at 95° for 262.0 meters to a point where the transect was near the dirt road. Transect B was laid at 185° south from a large honey locust tree located immediately south of a gulley and near a bend in the dirt road. Transect B continued 592.0 meters to near a large clearing adjacent to an old horseshoe bend of Clear Creek.

The Lower Elm Fork Stand

The lower Elm Fork stand is located 4.5 miles east and 4.0 miles north of Denton (Fig. 2). The stand has Trinity clay soils (1), an elevation of about 535 feet, and an area of 250 acres (Fig. 7). The streamside forest is bordered on the north by a cultivated field and pasture, on the east and south by the Elm Fork of the Trinity River, and on the west fenceline by a gulley and cultivated fields. The stand has undergone periodic light grazing, and cattle trails wind throughout the stand. Debris from periodic flooding were observed at heights of over 3 to 4 feet above ground and indicated both past and recent overflows. Gulley erosion and numerous branches have cut across the floodplain, and numerous ephemeral pools of varying size are scattered throughout the floodplain.

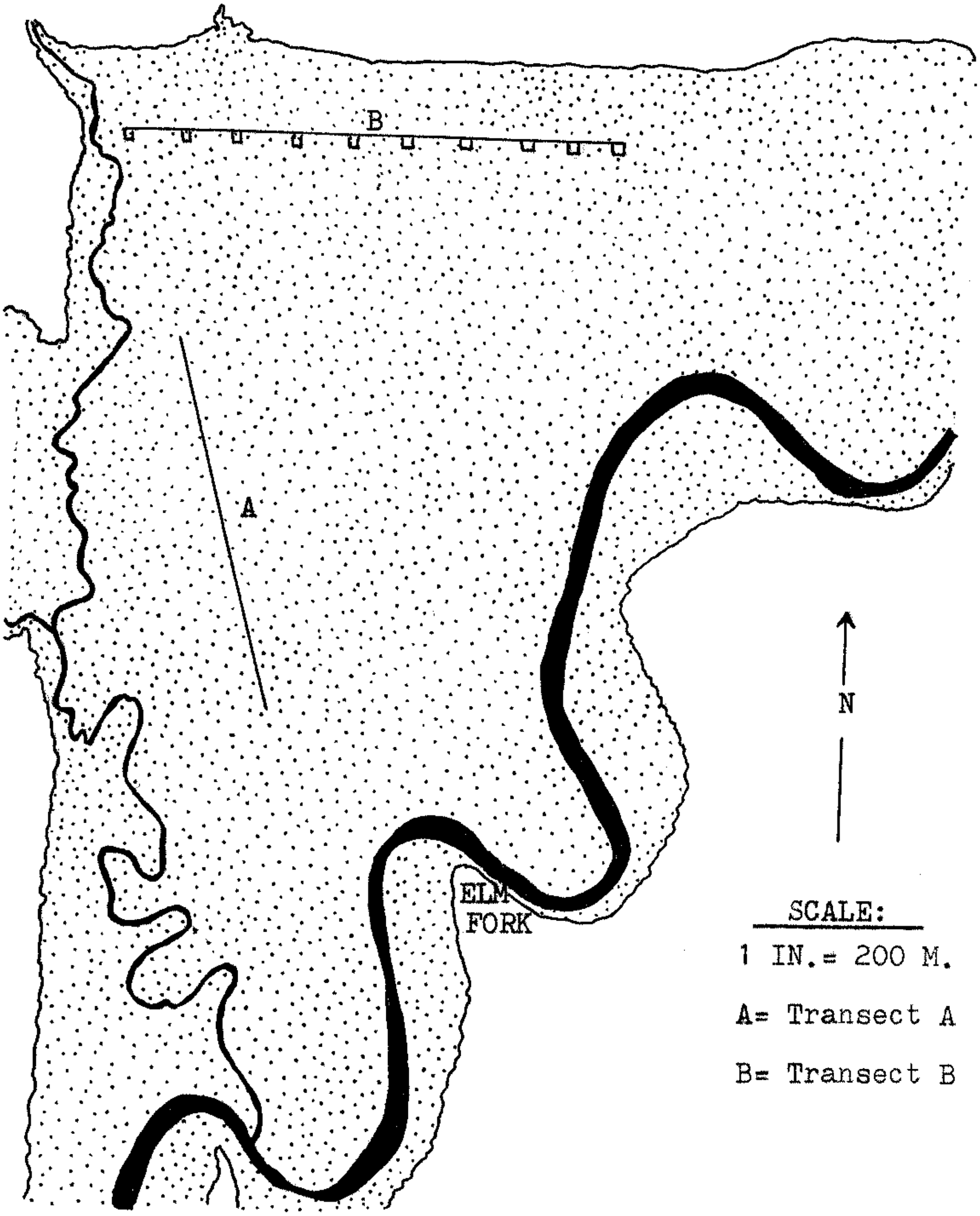

Fig. 7--The lower Elm Fork stand, showing Elm Fork of the Trinity River, transects, and quadrats.

Transect A was laid at 160° southeast from a hackberry tree located 150 meters east and 250 meters south of the northwest corner of the stand. The base tree was located east of a shallow, winding, intermittent stream. Transect A was continued for 441.0 meters to the bank of a deep, wide oxbow. Transect B was laid at 90° east from a burr oak tree located 25 meters east and 100 meters south of the northwest corner of the stand. Transect B continued east 586.0 meters, and roughly paralleled the northern fenceline to the edge of a large oxbow.

The Upper Elm Fork Stand

The upper Elm Fork stand is located 2.5 miles west and 2 miles north of Aubrey (Fig. 2). The stand has Frio clay soils (1) and an elevation of approximately 555 feet (Fig. 8). The stand is bordered on the north fenceline by an unimproved dirt road, on the east fenceline and west by cultivated fields, and on the south by Bray Branch and Elm Fork. The portion of the stand east of Elm Fork, comprising approximately 50 acres, was chosen for study because of its accessibility, size, and lack of major disturbance. The portions of the stand west of Elm Fork were not sampled due to their smaller size and greater inaccessibility. One rough trail had been cut eastward through the study site, but the area was otherwise relatively undisturbed.

Transect A was laid from an American elm tree located 10 meters south of the dirt road and 15 meters east of the creek. Transect A was laid southeast, 15 meters east and parallel to the eastern bank of Elm Fork, for a total distance of 504.0 meters. Transect B was laid at 70° northeast from a honey

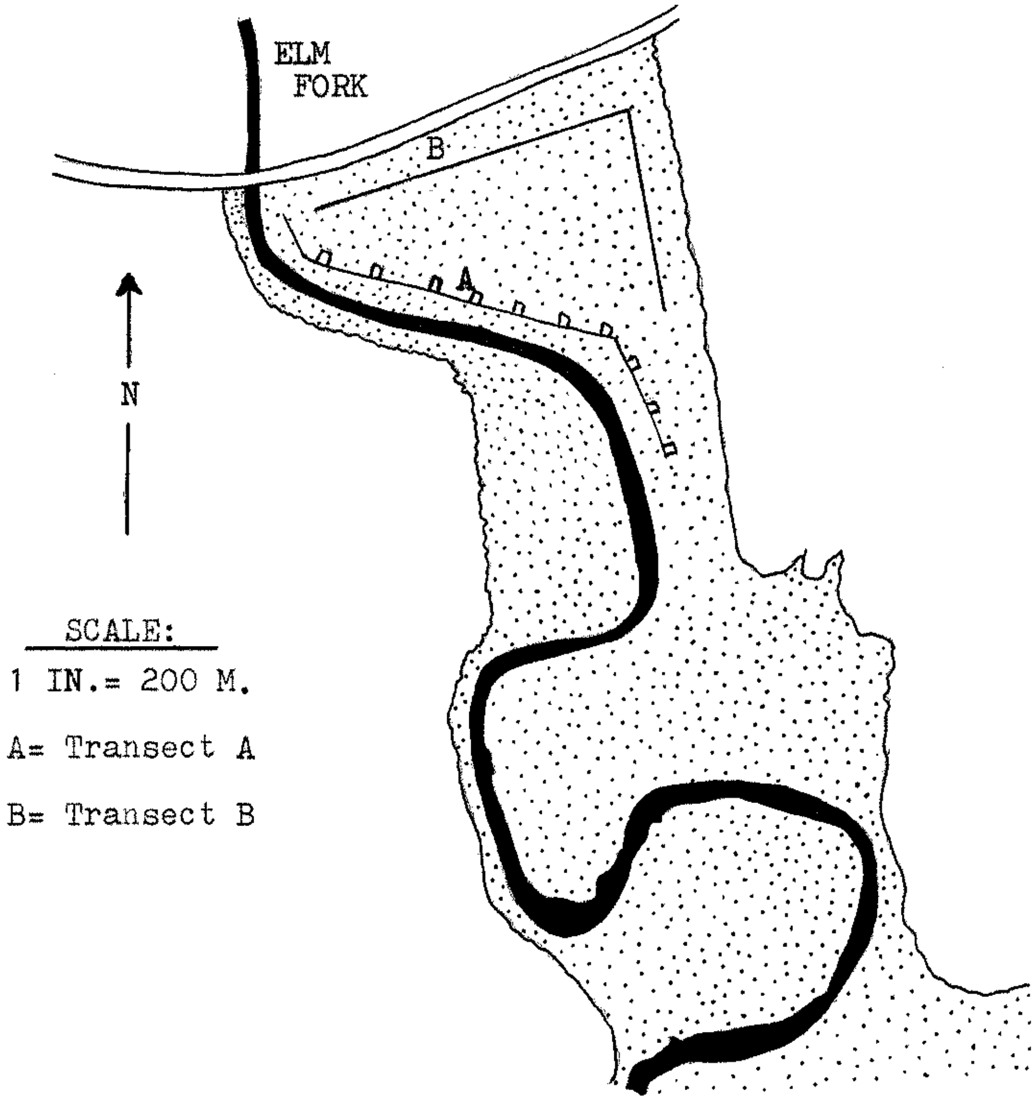

Fig. 8--The upper Elm Fork stand, showing the Elm Fork of the Trinity River, road, transects, and quadrats.

locust tree located 15 meters south of the dirt road and 25 meters east of Elm Fork. Transect B continued 340.5 meters to near the east fenceline and then at 17° southeast for 200.5 meters, for a total transect length of 541.0 meters.

The Lower Little Elm Stand

The lower Little Elm stand is located 4 miles east and 3 miles south of Aubrey (Fig. 2). The stand has an elevation

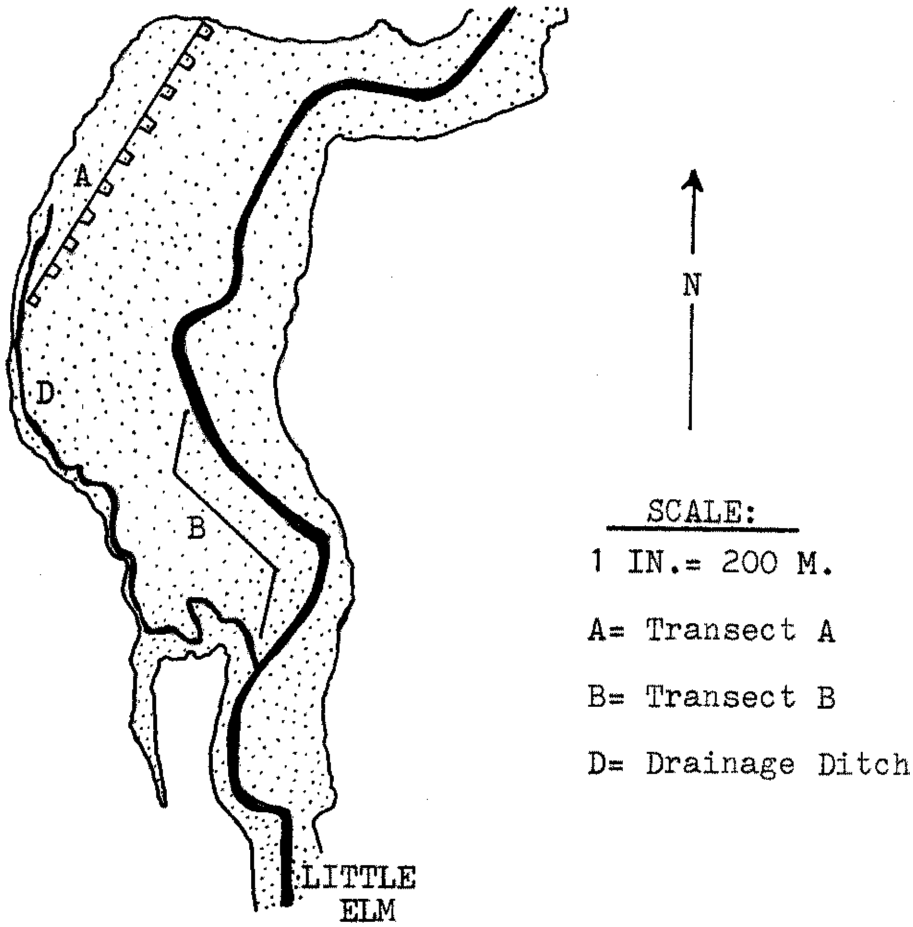

Fig. 9--The lower Little Elm stand, showing Little Elm, drainage ditch, transects, and quadrats.

of approximately 535 feet, has Durant fine sandy loam and Catalpa clay soils (1), and covers 46 acres (Fig. 9). The stand is bordered on the east and north by cultivated fields, and on the west and south by pastures and fields. The southwestern and southern boundaries of the stand are separated from the fields by a drainage ditch that empties into Little Elm Creek in the southeastern part of the stand. Minor refuse dumping in the ditch and creek were the only disturbances observed in this stand. The overall heights of the trees in this stand were considerably less than those observed in the stands on other creeks. Taller trees were found only within a few meters of the creek and in the southernmost part of the Little Elm lower stand.

Transect A was laid at 212° southwest from a two-boled cedar elm tree in the northwestern fenceline and continued southwest 330.0 meters to the edge of a drainage ditch at the western edge of the stand. Transect B originated from a large burr oak tree located 25 meters northwest of the confluence of a large drainage ditch and Little Elm Creek, and the transect paralleled Little Elm northward for 284.0 meters.

The Upper Little Elm Stand

The upper Little Elm stand is located 4.5 miles west and 2 miles north of Aubrey (Fig. 2). The stand has an elevation of 535 feet, has Catalpa clay soils (1), and comprises about 23 acres (Fig. 10). The stand is bounded on the east and northeast by a dirt road, on the northwest, west, and southwest fencelines by a cottonfield, on the southeast by pasture, and at the center of the south fenceline by a narrow strip of streamside forest. The overall heights of trees are similar to those of the lower Little Elm stand, with a few taller trees found near the creek. The western part of the stand exhibits little evidence of disturbance, but the eastern part is dissected by shallow drainage ditches and has been a site of refuse dumping near the dirt road.

Transect A was laid at 170° south from a base point on the north fenceline 23 meters east of the northwest corner of

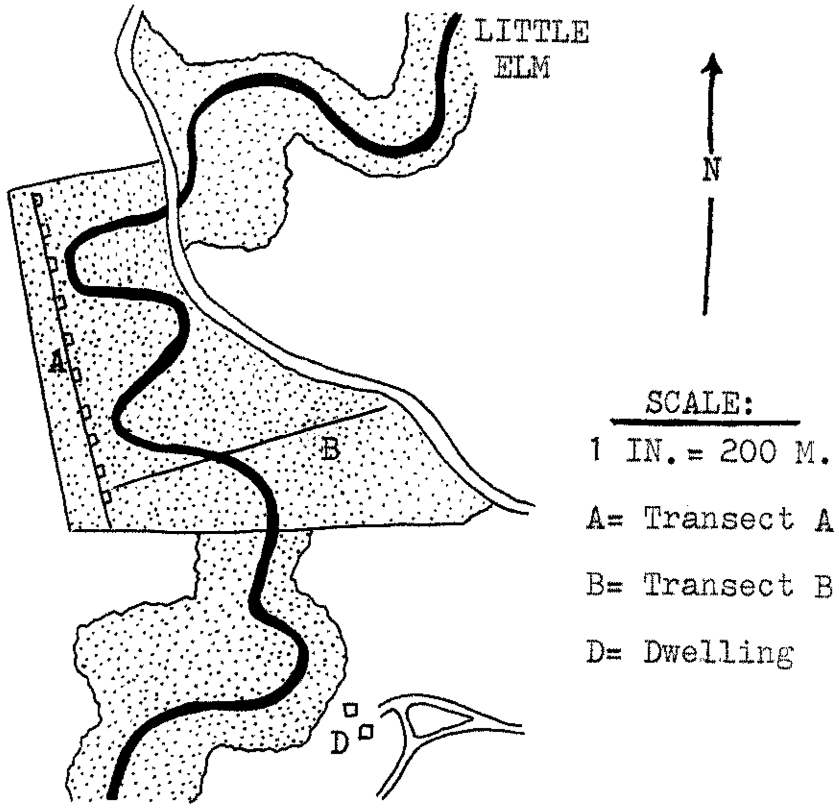

Fig. 10--The upper Little Elm stand, showing Little Elm, roads, dwellings, transects, and quadrats.

the stand and continued 351.0 meters to the south fenceline. Transect B was laid 78° east from a cedar elm tree located 15 meters east and 3 meters north of the southwest corner of the stand. Transect B continued northeast 303.0 meters to a dirt road at the eastern boundary of the stand.

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CHAPTER IV

RESULTS AND DISCUSSION

Results were grouped into four areas: firstly, measurements of distribution; secondly, measurements of biomass; thirdly, measurements of size distribution and seedling survival; and lastly, edaphic results. Measurements of the distribution of mature cedar elm trees within stands included frequency, transect-segment density, intertree distance, and lateral distance. The biomass measurements included diameter breast-high, basal area, and basal-area density. Size distribution and seedling-survival measurements included diameter breast-high size-class distribution and immature-tree density. Edaphic measurements included results of analyses of soil particle size of A_1 and B_1 layers at study sites.

Frequency

Frequency of mature cedar elm trees at stand and creek levels was determined as per cent occurrence of mature trees in total number of ten-meter-transect segments at the stand or creek. Frequencies greater than 90 per cent were observed at both the upper and lower Little Elm stands (Table I). The lower values of the stand-frequency values were observed to be 38.46 per cent at the upper Elm Fork stand, and 45.16 per cent at the lower Clear Creek stand.

TABLE I

FREQUENCY OF MATURE CEDAR ELM TREES AT STAND LEVEL

Stand	Total Number of Transect-Segments per Stand	Per Cent Transect-segments Occupied by Cedar Elm
Denton Creek		
Lower	112	76.79
Upper	82	59.76
Clear Creek		
Lower	62	45.16
Upper	85	76.47
Elm Fork		
Lower	103	70.87
Upper	104	38.46
Little Elm		
Lower	61	93.44
Upper	65	90.77

At creek levels, Little Elm exhibited the highest values for frequency, 94.44 per cent (Table II). Frequency values for other creeks ranged from a low of 54.59 per cent at Elm Fork to values of 62.27 per cent at Clear Creek and 69.59 per cent at Denton Creek.

TABLE II

FREQUENCY OF MATURE CEDAR ELM TREES AT CREEK LEVEL

Creek	Total Number of Transect-Segments per Creek	Per Cent Transect-Segments Occupied by Cedar Elm
Denton Creek	194	69.59
Clear Creek	147	62.27
Elm Fork	207	54.59
Little Elm	126	94.44

Frequency results indicated an uneven distribution of cedar elm trees within stands along Clear Creek and Elm Fork. High frequency and a relatively even distribution were found in Little Elm stands, and a moderately even distribution and frequency characterized the trees in Denton Creek stands. At the upper Elm Fork stand, most of the cedar elm trees were present in transect segments above a terrace in the eastern half of the stand and absent from the area immediately adjacent to the creekbank of Elm Fork. Transect B at the lower Clear Creek stand intercepted only 12 cedar elm trees in 340.0 meters. Cedar elm trees at the lower Clear Creek stand were mostly larger, older trees near the creekbank. Transect A at the lower Clear Creek stand was 275.0 meters in length, but intercepted 31 cedar elm trees of varying size in the northern part of the stand. Results indicated the lower Clear Creek stand to be a remnant stand with a heterogenous distribution of cedar elm trees.

Transect-Segment Density

Mean values of the number of mature cedar elm trees in transect segments of 10-meter lengths showed that values for upper and lower Little Elm stands were similar, as were the values for upper and lower Elm Fork stands (Table III). The differences between mean-density values of upper and lower stands of Denton Creek were very highly significant (0.001 level), as were density values of upper and lower stands of

TABLE III

MEAN- AND MAXIMUM-TRANSECT-SEGMENT-DENSITY VALUES OF ULMUS CRASSIFOLIA AT STAND LEVEL

Stand	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	t
Denton Creek					
Lower	2.36	11.00	2.18	192	3.54[e]
Upper	1.34	8.00	1.64		
Clear Creek					
Lower	0.69	5.00	0.98	145	3.44[e]
Upper	1.34	5.00	1.22		
Elm Fork					
Lower	1.31	7.00	1.26	205	1.95[f]
Upper	0.92	7.00	1.58		
Little Elm					
Lower	3.33	10.00	2.36	124	1.83[f]
Upper	4.15	13.00	2.73		

[a]Average number of trees per 10-meter-transect segment.

[b]Maximum number of trees per 10-meter-transect segment.

[c]Standard deviation.

[d]Degrees of freedom.

[e]Significant difference at 0.001 level.

[f]Not significantly different.

Clear Creek. The highest mean-transect-segment-density value was 4.16 for the upper Little Elm stand, while the lowest mean-density value was 0.69 trees per transect-segment for the lower Clear Creek stand. Results indicated widely varying transect-segment densities of cedar elm trees within stands along Denton Creek and Clear Creek, but similar transect-segment densities within stands along Elm Fork and Little Elm. Stand-transect-segment-density values paralleled frequency values, with lower values for the lower Clear Creek stand and the upper Elm Fork stand, and higher transect-segment-density values for Little Elm stands.

Elm Fork and Clear Creek cedar elm populations showed similar mean values (Table IV). The mean-transect-segment

TABLE IV

MEAN- AND MAXIMUM-TRANSECT-SEGMENT-DENSITY VALUES OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL

Creek	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	*t*
Denton Creek Clear Creek	1.93 1.07	11.00 5.00	1.46 1.17	339	6.03[e]
Denton Creek Elm Fork	1.93 1.12	11.00 7.00	1.46 1.44	399	6.16[e]
Denton Creek Little Elm	1.93 3.75	11.00 13.00	1.46 2.58	318	7.24[e]
Clear Creek Elm Fork	1.07 1.12	5.00 7.00	1.17 1.44	352	0.33[f]
Clear Creek Little Elm	1.07 3.75	5.00 13.00	1.17 2.58	271	11.34[e]
Elm Fork Little Elm	1.12 3.75	7.00 13.00	1.44 2.58	331	11.97[e]

[a]Average number of trees per 10-meter-transect segment.

[b]Maximum number of trees per 10-meter-transect segment.

[c]Standard deviation.

[d]Degrees of freedom.

[e]Significant difference at 0.001 level.

[f]Not significantly different.

density of cedar elm populations of Denton Creek and Little Elm were very highly different (0.001 level) from each other and the other creek populations. Mean-transect-segment-density values at the creek level decreased from a high of 3.75 at Little Elm to 1.93 at Denton Creek, to 1.12 at Elm Fork, and to a low of 1.07 at Clear Creek.

Intertree Distance

An additional measure of density was determined by comparison of intertree-distance values, in that a large mean-intertree-distance value indicated a small mean-density value for a stand or creek. A comparison of mean-intertree-distance values is shown in Table V.

TABLE V

MEAN- AND MAXIMUM-INTERTREE-DISTANCE VALUES OF *ULMUS CRASSIFOLIA* AT STAND LEVEL

Stand	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	*t*
Denton Creek					
Lower	4.14	48.0	5.97	372	2.79[e]
Upper	6.36	72.0	9.06		
Clear Creek					
Lower	10.97	58.5	13.70	155	2.17[f]
Upper	7.07	56.5	8.23		
Elm Fork					
Lower	7.46	70.0	9.41	229	0.91[g]
Upper	10.02	262.0	30.69		
Little Elm					
Lower	2.81	20.0	3.17	471	1.31[g]
Upper	2.40	29.0	3.45		

[a]Average number of meters per intertree distance.

[b]Maximum number of meters per intertree distance.

[c]Standard deviation.

[d]Degrees of freedom.
[e]Significant difference at 0.01 level.
[f]Significant difference at 0.05 level.
[g]Not significantly different.

The mean value of intertree distance, meters distance between cedar elm trees along the transect line, showed the same patterns of significance as did values obtained by analysis of transect-segment density. Intertree-distance values are compared at creek level in Table VI.

TABLE VI

MEAN- AND MAXIMUM-INTERTREE-DISTANCE VALUES OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL

Creek	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	*t*
Denton Creek Clear Creek	4.76 8.17	72.0 58.5	7.07 10.14	529	4.43[g]
Denton Creek Elm Fork	4.76 8.54	72.0 262.0	7.07 21.03	603	3.20[e]
Denton Creek Little Elm	4.76 2.59	72.0 29.0	7.07 3.33	845	10.42[g]
Clear Creek Elm Fork	8.17 8.54	58.5 262.0	10.14 21.03	386	0.20[f]
Clear Creek Little Elm	8.17 2.59	58.5 29.0	10.14 3.33	628	10.42[g]
Elm Fork Little Elm	8.54 2.59	262.0 29.0	21.03 3.33	702	6.01[g]

[a]Average number of meters per intertree distance.
[b]Maximum number of meters per intertree distance.
[c]Standard deviation.

[d]Degrees of freedom.

[e]Significant difference at 0.01 level.

[f]Not significantly different.

[g]Significant difference at 0.001 level.

Lateral Distance

So that exact locations of cedar elm within stands could be mapped and variations in lateral distribution of cedar elm along transects could be determined, lateral distance was recorded for each cedar elm tree whose crown was intercepted by the transect line. Stand-lateral-distance values are compared in Table VII.

TABLE VII

MEAN- AND MAXIMUM-LATERAL-DISTANCE VALUES OF *ULMUS CRASSIFOLIA* AT STAND LEVEL

Stand	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	*t*
Denton Creek					
Lower	1.18	6.0	1.08	372	5.53[e]
Upper	1.19	6.0	1.42		
Clear Creek					
Lower	2.35	6.5	1.73	155	2.64[f]
Upper	1.66	7.0	1.35		
Elm Fork					
Lower	1.57	6.0	1.24	229	3.06[f]
Upper	1.10	6.0	1.03		
Little Elm					
Lower	1.06	6.5	1.00	471	0.89[g]
Upper	0.98	4.0	0.94		

[a]Average number of meters per lateral distance.

[b]Maximum number of meters per lateral distance.

[c]Standard deviation.
[d]Degrees of freedom.
[e]Significant difference at 0.001 level.
[f]Significant difference at 0.01 level.
[g]Not significantly different.

Lateral distances in upper and lower stands on both Clear Creek and Elm Fork were found to be highly significantly different (0.01 level), while stands on Denton Creek were very highly significantly different (0.001 level). The lateral distances of the upper and lower stands of Little Elm were similar. Lateral-distance-mean values for stands varied from 0.98 meters at the upper Little Elm stand to a high of 2.35 meters at the lower Clear Creek stand, for an overall range of only 1.37 meters at stand level.

At the creek level, Denton Creek and Elm Fork exhibited similar lateral-distance values (Table VIII). The lateral-distance values among all other creeks showed very highly significant differences (0.001 level). Lateral-distance-mean values at creek level varied from a low of 1.01 meters at Little Elm to 1.87 meters at Clear Creek, for an overall range of 0.86 meters.

Lateral distance proved to be a parameter limited by tree crown size. The maximum lateral distance of a cedar elm tree was limited to the maximum length of a cedar elm branch extending from the bole of the tree to the transect line. The maximum-recorded lateral distance was 7.0 meters.

TABLE VIII

MEAN- AND MAXIMUM-LATERAL-DISTANCE VALUES OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL

Creek	Mean[a]	Max.[b]	Std. Dev.[c]	Df[d]	*t*
Denton Creek Clear Creek	1.38 1.87	6.0 7.0	1.21 1.52	529	3.89[e]
Denton Creek Elm Fork	1.38 1.38	6.0 6.0	1.21 1.18	603	0.02[f]
Denton Creek Little Elm	1.38 1.01	6.0 6.5	1.21 0.97	854	4.91[e]
Clear Creek Elm Fork	1.87 1.38	7.0 6.0	1.52 1.18	386	3.51[e]
Clear Creek Little Elm	1.87 1.01	7.0 6.5	1.52 0.97	628	8.19[e]
Elm Fork Little Elm	1.38 1.01	6.0 6.5	1.18 0.97	702	4.42[e]

[a]Average number of meters per lateral distance.

[b]Maximum number of meters per lateral distance.

[c]Standard deviation.

[d]Degrees of freedom.

[e]Significant difference at 0.001 level.

[f]Not significantly different.

Overall, the lateral-distance parameter was seen to be more useful in mapping trees for relocation and restudy than measuring differences between populations of cedar elm trees.

Diameter Breast-High

Analysis of dbh (diameter breast-high) mean values of cedar elm trees at the stand level (Table IX) indicated that

TABLE IX

MEAN- AND MAXIMUM-DIAMETER BREAST-HIGH VALUES OF *ULMUS CRASSIFOLIA* AT STAND LEVEL[a]

Stand	Mean[b]	Max.[c]	Std. Dev.[d]	Df[e]	*t*
Denton Creek					
Lower	6.08	25.1	4.17	372	6.22[f]
Upper	9.42	23.2	5.88		
Clear Creek					
Lower	9.20	25.0	4.76	155	0.22[g]
Upper	9.42	29.8	5.87		
Elm Fork					
Lower	9.45	19.4	4.59	229	8.15[f]
Upper	4.74	22.2	3.92		
Little Elm					
Lower	5.73	18.9	3.14	471	2.24[h]
Upper	5.13	15.4	2.73		

[a]A tree with more than one bole at diameter breast-high (measured 4½ feet above the base of the tree) was assigned a single dbh value calculated from the total-combined-basal areas of the individual boles.

[b]Average diameter in inches.

[c]Maximum diameter in inches.

[d]Standard deviation.

[e]Degrees of freedom.

[f]Significant difference at 0.001 level.

[g]Not significantly different.

[h]Significant difference at 0.05 level.

values for the upper and lower Clear Creek stands were similar. Conversely, the values of upper and lower stands of other creeks were significantly different (0.05 level) for Little Elm and highly significantly different (0.001 level) for Denton Creek and Elm Fork.

At the creek level, Denton Creek and Elm Fork populations exhibited similar mean dbh values (Table X). Conversely, the

TABLE X

MEAN AND MAXIMUM-DIAMETER BREAST-HIGH VALUES OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL[a]

Creek	Mean[b]	Max.[c]	Std. Dev.[d]	Df[e]	*t*
Denton Creek Clear Creek	7.01 9.34	25.1 29.8	4.95 5.54	529	4.78[f]
Denton Creek Elm Fork	7.01 7.57	25.1 22.2	4.95 4.96	603	1.35[g]
Denton Creek Little Elm	7.01 5.38	25.1 18.9	4.95 2.93	845	5.97[f]
Clear Creek Elm Fork	9.34 7.57	29.8 22.2	5.54 4.96	386	3.92[f]
Clear Creek Little Elm	9.34 5.38	29.8 18.9	5.54 2.93	628	11.47[f]
Elm Fork Little Elm	7.57 5.38	22.2 18.9	4.96 2.93	702	7.34[f]

[a]A tree with more than one bole at diameter breast-high (measured 4½ feet above the base of the tree) was assigned a single dbh value calculated from the total-combined-basal areas of the individual boles.

[b]Average diameter in inches.

[c]Maximum diameter in inches.

[d]Standard deviation.

[e]Degrees of freedom.

[f]Significant difference at 0.001 level.

[g]Not significantly different.

cedar elm populations at Clear Creek and Elm Fork had highly significantly different (0.001 level) mean dbh values. All other comparisons of mean dbh values showed very highly significantly different values (0.001 level) among creeks.

Basal Area

The parameters of average basal area per tree and average-basal-area density were used as indicators of cover and biomass distribution, respectively. Basal-area values, compared as average basal area per tree and basal-area density at the stand level, are shown in Table XI.

TABLE XI

AVERAGE BASAL AREA PER TREE AND BASAL-AREA DENSITY OF *ULMUS CRASSIFOLIA* AT STAND LEVEL[a]

Stand	Average Basal Area per Tree[b]	Average Basal Area Density[c]
Denton Creek		
Lower	29.44	6.86
Upper	69.71	9.33
Clear Creek		
Lower	66.52	5.61
Upper	69.71	9.33
Elm Fork		
Lower	70.04	9.25
Upper	17.36	1.61
Little Elm		
Lower	25.78	8.54
Upper	20.63	8.50

[a]Basal area = $(\frac{1}{2}\ \text{dbh})^2$.

[b]Expressed as square inches per tree.

[c]Expressed as square inches per meter.

Results of average basal area per tree were derived from mean dbh values and showed the same patterns of differences and similarities as dbh values. A group with high average basal area per tree (66.52-70.04 square inches per tree) included upper Denton Creek, lower and upper Clear Creek, and lower Elm Fork stands. A second group with a relatively low average basal area (17.36-29.44 square inches per tree) included lower Denton Creek, upper Elm Fork, and both Little Elm stands.

Basal-area-density values were high (8.50-9.33 square inches per meter of transect length) for the upper Denton Creek, upper Clear Creek, lower Elm Fork, and both Little Elm stands. Intermediate values (5.61-6.86 square inches per meter of transect length) were present at the lower Denton Creek stand and lower Clear Creek stand, and an extremely low value of 1.61 square inches per meter was found for the upper Elm Fork stand.

Results at the creek level (Table XII) showed a distribution with low basal area per tree at Little Elm, large trees with intermediate basal area at Denton Creek and Elm Fork, and large trees with high basal area at Clear Creek. The highest basal-area density was 8.50 square inches per meter of transect at Little Elm. Intermediate basal-area-density values were present on Denton Creek and Clear Creek, and a low value was found at Elm Fork.

TABLE XII

AVERAGE BASAL AREA PER TREE AND BASAL-AREA DENSITY OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL[a]

Creek	Average Basal Area per Tree[b]	Average Basal Area Density[c]
Denton Creek	39.11	7.55
Clear Creek	68.56	7.29
Elm Fork	45.04	5.00
Little Elm	22.76	8.50

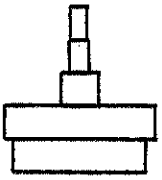
[a]Basal area = $(\frac{1}{2}\ \text{dbh})^2$.

[b]Expressed as square inches per tree.

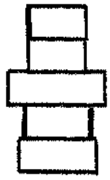
[c]Expressed as square inches per meter.

Diameter Breast-High Size-Class Distribution

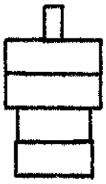
Per cent composition of dbh size classes of cedar elm at stand level is shown in Fig. 11. A per cent composition greater than 25.00 per cent in size classes A and B and a more or less pyramidal size-class distribution pattern were present in the lower Denton Creek, upper Elm Fork, lower Little Elm, and upper Little Elm stands. The large trees of size-class E were absent from the upper Little Elm stand. Upper Denton Creek and lower Clear Creek stands showed similar distribution values for A, B, and C size-classes. The D and E size-classes made up a large percentage of cedar elm found in the upper Denton Creek stand and had similar percentage values. A large size-class D and smaller number of the older, largest trees of size-class E were found at the lower Clear



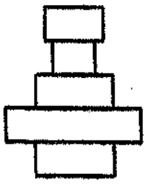
Lower Denton Creek		Upper Denton Creek
3.41	E	15.45
6.44	D	14.55
12.50	C	24.55
40.15	B	21.82
37.50	A	23.64



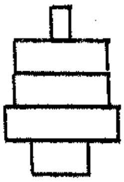
Lower Denton Creek   Upper Denton Creek



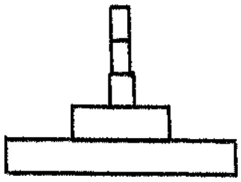
Lower Clear Creek		Upper Clear Creek
4.65	E	17.54
27.91	D	11.40
27.91	C	18.42
18.60	B	34.21
20.93	A	18.42



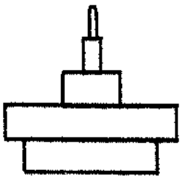
Lower Clear Creek   Upper Clear Creek



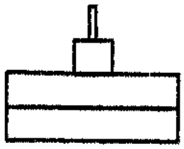
Lower Elm Fork		Upper Elm Fork
6.67	E	3.14
24.44	D	3.14
25.92	C	7.29
28.89	B	26.04
14.07	A	60.42



Lower Elm Fork   Upper Elm Fork



Lower Little Elm		Upper Little Elm
1.48	E	0.00
3.45	D	2.59
14.29	C	12.59
44.33	B	42.22
36.45	A	42.59



Lower Little Elm   Upper Little Elm

Dbh size-class values:

A (1.5 - 4.0 inches dbh)   C (8.1 - 12.0 inches dbh)

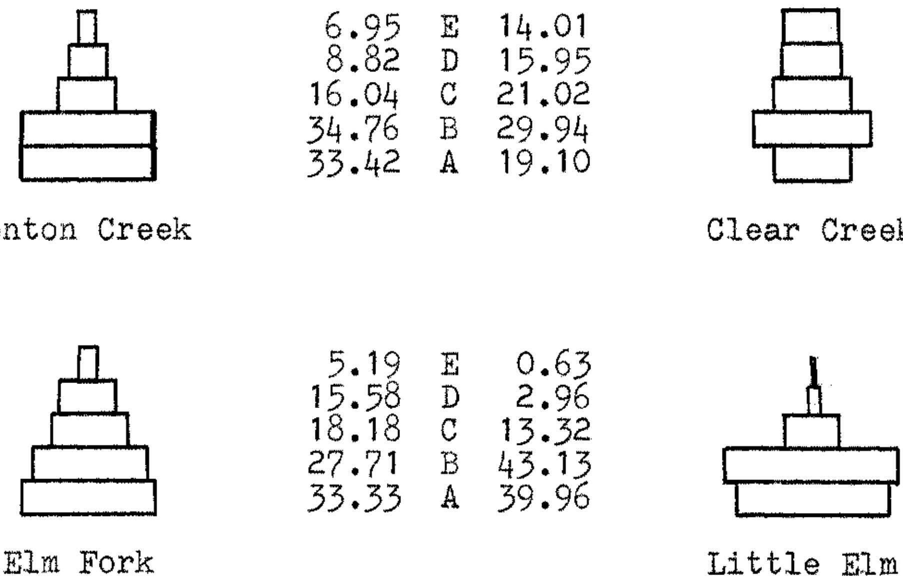
B (4.1 - 8.0 inches dbh)   D (12.1 - 16.0 inches dbh)

E (16.1 inches dbh or larger)

Fig. 11--Dbh size-class distribution, showing per cent composition at stand level.

Creek stand. The upper Clear Creek stand had a maximum value of 34.21 per cent in size-class B, 17.57 per cent as old, large trees of size class E, 18.42 per cent as small trees of size-class A, and varying percentages in other size-classes. Lower Elm Fork had a fairly even distribution of size-classes B, C, and D, with a small representation of 14.07 per cent in size-class A.

Dbh size-class distribution patterns at the creek level are shown in Figure 12. The pyramidal distribution pattern of large numbers of small trees and decreasing percentages of larger, older trees was indicative of healthy, reproducing



Dbh size-class values:

A (1.5 - 4.0 inches dbh) C (8.1 - 12.0 inches dbh)
B (4.1 - 8.0 inches dbh) D (12.1 - 16.0 inches dbh)
E (16.1 inches dbh or larger)

Fig. 12--Dbh size-class distribution, showing per cent composition at creek level.

populations at Denton Creek and Elm Fork. The dbh size-class distribution pattern of Clear Creek exhibited a past, peak period of numbers of cedar elm trees in the B size-class, fewer numbers in the A size-class, and larger numbers of the older, larger trees. Dbh size-class distribution at Little Elm indicated cedar elm trees along this creek to be smaller trees, with a few older, larger trees.

Immature Trees

Analysis of mean values of numbers of young cedar elm trees per ten- by ten-meter quadrats (Table XIII) showed that population densities of immature cedar elm were similar in upper stands of Denton Creek, Elm Fork, and Little Elm.

TABLE XIII

FREQUENCY AND MEAN- AND MAXIMUM-IMMATURE-TREE-DENSITY VALUES OF *ULMUS CRASSIFOLIA* AT STAND LEVEL

Stand	F[a]	Mean[b]	Max.[c]	Std. Dev.[d]	*t*
Denton Creek					
Lower	80.00	10.60	67.00	20.59	0.69[e]
Upper	100.00	16.80	72.00	19.80	
Clear Creek					
Lower	80.00	4.70	12.00	4.60	2.46[f]
Upper	50.00	1.00	3.00	1.25	
Elm Fork					
Lower	60.00	0.80	2.00	0.79	1.71[e]
Upper	50.00	4.60	19.00	6.96	
Little Elm					
Lower	80.00	2.50	7.00	2.17	1.86[e]
Upper	90.00	5.80	15.00	5.18	

[a]Frequency.

[b]Average density (number of immature trees per quadrat).

[c]Maximum density of immature trees per quadrat.

[d]Standard deviation.

[e]Values not significantly different at 18 degrees of freedom.

[f]Significant difference at 0.05 level, with 18 degrees of freedom.

Immature cedar elm tree densities in upper and lower stands of Clear Creek were significantly dissimilar at the 0.05 level. Frequency of immature cedar elm trees was determined as per cent occurrence in total number of 10-by 10-meter quadrats at the stand or creek. Number and frequency of immature cedar elm trees were low at the upper Clear Creek stand and both Elm Fork stands, and high at Denton Creek, lower Clear Creek, and Little Elm stands.

At the creek level, quadrat studies indicated that young cedar elm trees were present in moderate densities on Clear Creek, Elm Fork, and Little Elm (Table XIV). These populations were significantly different (0.05 level) from those of Denton Creek, which had a distinct, high density of 13.70 cedar elm trees per quadrat. Low densities were 2.70 and 2.85 immature cedar elm trees per quadrat at Elm Fork and Clear Creek, respectively, while a density of 4.15 immature cedar elm trees per quadrat was observed at Little Elm. Frequency values were low at Clear Creek and Elm Fork, while high values were present for Denton Creek and Little Elm.

TABLE XIV

FREQUENCY AND MEAN- AND MAXIMUM-IMMATURE-TREE-DENSITY VALUES OF *ULMUS CRASSIFOLIA* AT CREEK LEVEL

Creek	F[a]	Mean[b]	Max.[c]	Std. Dev.[d]	*t*
Denton Creek Clear Creek	90.00 65.00	13.70 2.85	72.00 12.00	19.92 3.79	2.39[e]
Denton Creek Elm Fork	90.00 55.00	13.70 2.70	72.00 19.00	19.92 5.20	2.39[e]
Denton Creek Little Elm	90.00 85.00	13.70 4.15	72.00 15.00	19.92 4.22	2.10[e]
Clear Creek Elm Fork	65.00 55.00	2.85 2.70	12.00 19.00	3.79 5.20	0.10[f]
Clear Creek Little Elm	65.00 85.00	2.85 4.15	12.00 15.00	3.79 4.22	1.03[f]
Elm Fork Little Elm	55.00 85.00	2.70 4.15	19.00 15.00	5.20 4.22	0.97[f]

[a]Frequency.

[b]Average density (number of immature trees per quadrat).

[c]Maximum density of immature trees per quadrat.

[d]Standard deviation.

[e]Significant difference at 0.05 level, with 38 degrees of freedom.

[f]Values not significantly different at 38 degrees of freedom.

Close examination of stand data (Table XV) indicated a possible relationship between numbers of immature cedar elm trees and numbers of immature hackberry (*Celtis laevigata* Willd.), red ash (*Fraxinus pennsylvanica* Marsh.), and soapberry (*Sapindus drummondii* Hook and Arn.). The highest per cent composition value of cedar elm was found in the lower

TABLE XV

PER CENT COMPOSITION OF IMMATURE TREES AT STAND LEVEL*

Stand	Number of Trees	Per Cent Cedar Elm Trees	Per Cent Hackberry Trees	Per Cent Red Ash Trees	Per Cent Soapberry Trees	Per Cent Remaining Trees
Denton Creek						
Lower	264	40.15	8.33	4.92	7.58	35.02
Upper	481	34.93	15.59	27.67	2.91	18.90
Clear Creek						
Lower	361	13.02	29.63	14.96	13.86	28.53
Upper	226	4.43	18.58	3.98	33.63	40.38
Elm Fork						
Lower	400	2.00	63.75	23.50	0.75	10.00
Upper	186	24.73	13.98	8.60	15.59	37.10
Little Elm						
Lower	141	17.73	46.10	0.71	2.84	32.62
Upper	329	17.63	25.23	38.91	2.74	15.49

*Per cent composition of immature trees, based on per cent total number of immature trees in 10 quadrats, each 10-by 10-meters, at each stand.

Denton Creek stand, which also had the lowest per cent composition value for hackberry. Conversely, hackberry seedlings dominated seedling numbers found in the lower Elm Fork stand, which had the lowest per cent composition value for cedar elm. Anomalous patterns of small per cent composition values of cedar elm and hackberry seedlings at upper Clear Creek may be due to competition with the large numbers of immature soapberry trees present. Red ash may have been an important competitor in the upper Little Elm and upper Denton Creek stands. The remaining species of immature trees were each present in small numbers in stands, but accumulatively may have been an important competitive factor. It is suggested that competition among seedlings strongly influenced per cent composition patterns of immature cedar elm trees in stands.

Mechanical Analysis of Soils

Soil-particle size as a possible factor influencing population differences between stands was investigated by the hydrometric analysis of soil samples of the A_1 and B_1 layers of each stand. Per cent composition values of sand, silt, and clay of soil samples of the A_1 and B_1 layers of each stand are shown in Table XVI.

TABLE XVI

PER CENT COMPOSITION OF SAND, SILT, AND CLAY OF A_1-AND B_1-SOIL LAYERS

Stand	A_1 Layer			B_1 Layer		
	Sand	Silt	Clay	Sand	Silt	Clay
Denton Creek						
Lower	58.44	16.00	25.56	49.00	14.00	37.00
Upper	53.52	23.00	21.48	74.00	10.00	16.00
Clear Creek						
Lower	50.72	19.00	30.28	65.84	15.00	19.16
Upper	68.16	28.00	3.84	85.44	10.00	4.56
Elm Fork						
Lower	14.00	42.00	44.00	12.00	36.00	52.00
Upper	30.52	36.00	33.48	34.60	37.00	28.40
Little Elm						
Lower	26.60	28.00	45.40	22.60	30.00	47.40
Upper	25.72	26.00	48.28	21.72	29.00	49.28

Results of mechanical analysis of soil-particle size showed several compositional patterns present in the A_1-soil horizon samples (Fig. 13).

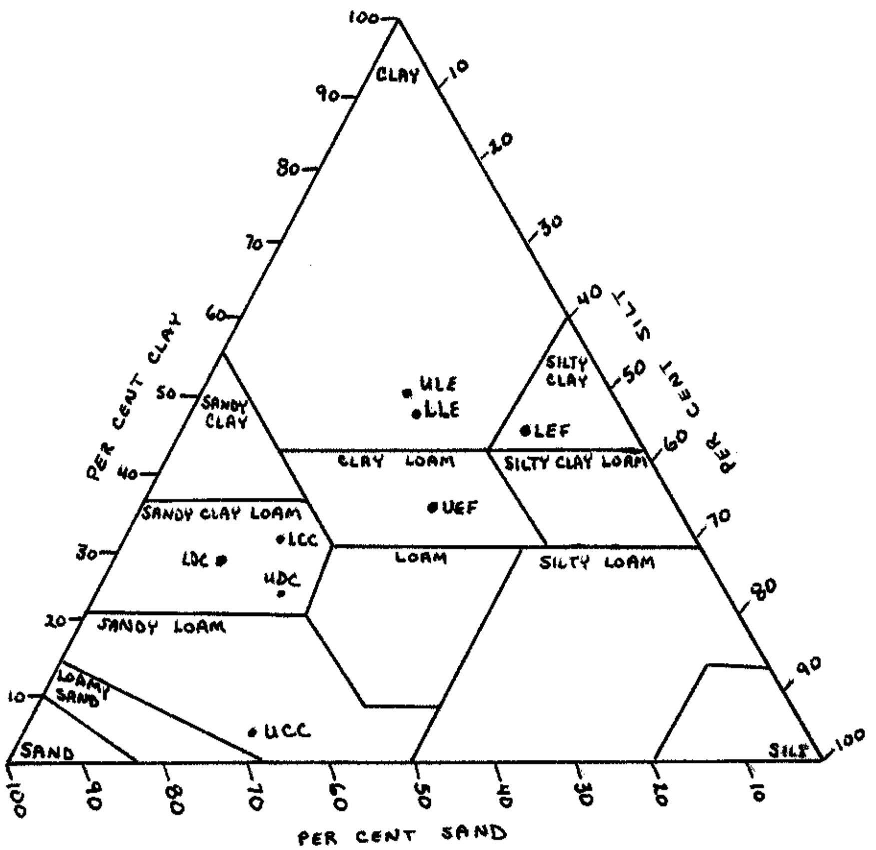


Fig. 13--Soil texture classification of A_1 soils, showing distribution of A_1 soils of stands.

Both the lower and the upper Denton Creek stands and the lower Clear Creek stand were classified as Frio clay, but had A_1 soils containing high amounts of sand. Denton Creek had drainage not only from Grand Prairie soils, but also drained large areas of Trinity Paluxy sands in Wise County. The soils of both of the Denton Creek stands were most probably derived from both Grand Prairie and Trinity Paluxy substrates. The

A_1 soil of the lower Clear Creek stand contained a high percentage of sand and 30.28 per cent clay. Further observations and soil analyses indicated the composition of the A_1 layer was heterogenous throughout the lower Clear Creek stand, possibly because of local soil erosion from nearby fields.

A high percentage of sand and low percentage of clay were found in the A_1 layer of the Frio clay soil of the upper Clear Creek stand. The composition may have been caused by the location of the stand upstream from the major influx of silt and clay derived from the limestone soils of the Grand Prairie. Rather, the upper Clear Creek stand was influenced almost exclusively by drainage from Trinity Paluxy sands.

The Frio clay of the lower Elm Fork stand was low in amount of sand, but high in approximately equal amounts of silt and clay. In addition to Elm Fork alluvium, soils of the Grayson-Main Street of the Grand Prairie entered this stand in drainage waters from Culp Branch in the northwestern portion of the stand.

The A_1 layer of the Trinity clay of the upper Elm Fork stand had nearly equal proportions of sand, silt, and clay. The area of the upper Elm Fork stand sampled was the easternmost portion of the stand and located nearest drainage from Woodbine sandstone. The stand was located immediately below the confluence of Elm Fork and the sand-laden Isle du Bois tributary of Elm Fork.

The A_1 layers of the Catalpa clays of the Little Elm stands had low proportions of sand and silt, and high proportions of clay. Above the stands, the main drainage of Little Elm Creek was from the calcareous, Eagleford limestone soils of the Blackland Prairie, with minimal drainage from the Woodbine sandstone area to the west. The short distance between the Little Elm stands further contributed to the similarity of their soil compositions.

Analyses of B_1-soil horizons showed similar patterns of composition as those of the A_1 horizons (Fig. 14).

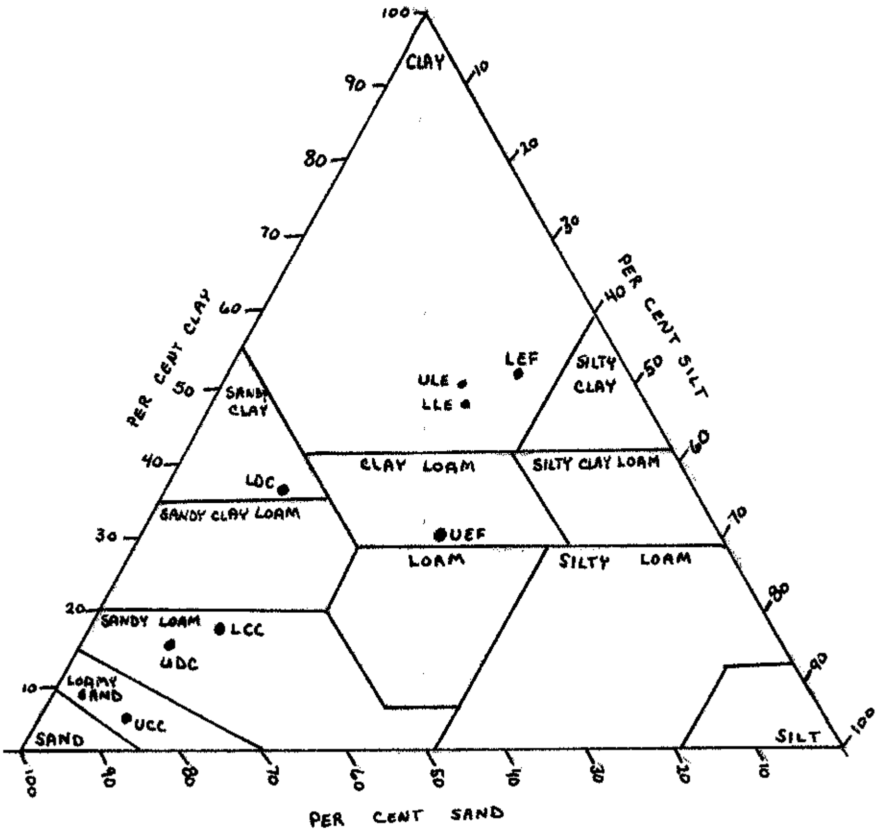


Fig. 14--Soil texture classification of B_1 soils, showing distribution of B_1 soils of stands.

Analyses of both the A_1 and B_1 horizons showed high percentages of sand in Denton Creek and Clear Creek stands and intermediate to low percentages of sand in Elm Fork and Little Elm stands. The B_1 horizon of both the upper Denton Creek stand and the upper Clear Creek stand had decreased percentages of silt and increased percentages of sand in comparison to A_1-horizon percentages. The B_1 horizon of lower Denton Creek had more clay and less sand than did the A_1 horizon, and the B_1 horizon of the lower Elm Fork stand had an increased percentage of clay and a slightly decreased percentage of silt in comparison to A_1-horizon values.

Although variations in soil composition existed at each stand, casual field observations revealed a high moisture content in subsoils throughout the year. The high moisture content in the B_1 samples might have been the result of a high water table caused by the nearby creeks, and would have lessened the influence of soil-particle size as a possible cause of differences in cedar elm populations. In the A_1 horizon, the relative amounts of sand, silt, and clay may have influenced seedling survival. The extremely sandy, clay-deficient topsoil of the upper Clear Creek stand, combined with competition from other seedling species, may have contributed to poor immature cedar elm survival at this stand.

Stand Comparisons

Denton Creek stands exhibited significantly higher densities of immature cedar elm trees than densities observed at stands on other creeks. Both of the Denton Creek stands had similar mature-tree densities and Frio clay soils with sandy-clay A_1-layers, but many other parameters were noticably different. The B_1 layer of the lower Denton Creek stand was a sandy clay, but the B_1 layer of the upper Denton Creek stand was a sandy loam. The lower stand had a smaller average dbh, basal area per tree, and basal area per meter than did the upper stand. The frequency of cedar elm at the lower Denton Creek stand was greater than that of the upper Denton Creek stand. The dbh size-class distribution indicated a healthy, reproducing population at the lower stand, and an older but reproducing population at the upper stand. Since immature cedar elm tree density was greater in the upper stand but size-class A and B distribution values were greater at the lower stand, seedling mortality might have been higher at the upper stand. Since the upper Denton Creek stand was a small, remaining segment of a larger stand, transects were relatively close to the creek, and might have intercepted the larger trees present within the stand. Most larger trees found at the lower Denton Creek stand were in close proximity to the creek.

Although both populations on Clear Creek possessed large trees, similar average-dbh, and similar basal-area values per tree, many differences were present. The upper Clear Creek stand had a lower density of immature cedar elm trees, a higher density and frequency of mature cedar elm trees, and a correspondingly higher basal area per meter of transect than the lower Clear Creek stand. Both Clear Creek stands had Frio clay soils, but mechanical analysis and field observations indicated distinct differences in soil composition. The upper Clear Creek stand A_1 and B_1 layers had large percentages of sand, moderate amounts of silt, and minute percentages of clay. In contrast, the lower Clear Creek stand had moderate amounts of clay in both the A_1 and B_1 layers.

The lack of clay binding together the topsoil of the upper Clear Creek stand, combined with a lack of litter, many tall trees with large crowns present, and a dense herbage-cover in clearings, contributed to the low density and paucity of immature cedar elm trees at this stand. Soapberry seedlings dominated immature trees present in the upper stand, while the lower stand was dominated by hackberry seedlings. The dbh size-class distribution for the upper Clear Creek stand indicated a population of cedar elm deficient in the smaller trees of dbh size-class A and indicated past peak periods of reproductive success in dbh size-class B. The lower Clear Creek stand had fewer of the largest trees, but had predominately large trees of dbh size-class C throughout the stand. Soil erosion and flooding had felled trees at the lower Clear Creek stand and had created clearings which supported large numbers of young ash and some young cedar elm trees.

Few similarities were observed between the upper and the lower Elm Fork stands. The Trinity clay soil of lower Elm Fork was a silty clay A_1 layer with a clay B_1 subsoil layer, while the Frio clay soil of the upper Elm Fork stand had both A_1 and B_1 clay loam layers. Both stands possessed similar, low densities of mature and immature cedar elm trees, but other population parameters showed significant differences between stands. The lower Elm Fork stand had a fairly high frequency of cedar elm trees, large average dbh, high basal area per meter, high basal area per tree, and extremely low density of immature cedar elm trees.

Analysis of dbh size class distribution of the lower Elm Fork stand revealed a population of relatively large cedar elm trees lacking the smaller trees of dbh size class A and showing extremely poor reproduction. Field observations of the lower Elm Fork stand showed savannah-like areas with a dense grass cover, large areas subjected to prolonged inundation, and severe, local competition with hackberry seedlings. Conversely, the upper Elm Fork stand showed heterogenous tree composition and low densities of cedar elm that corresponded to field observations of large areas devoid of any cedar elm and other areas where the transects cut through dense thickets of cedar elm. Competition, ground cover, and areas of open canopy available for seedling survival appeared to have influenced cedar elm seedling distribution in the upper Elm Fork stand. Although low in overall immature tree density, immature cedar elm trees were present in moderate percentages and analysis of size-class distribution indicated previous reproductive success and large numbers of small cedar elm trees in dbh size-classes A and B in the upper Elm Fork stand.

Populations of cedar elm trees in Little Elm stands were similar in transect-segment density, intertree distance, frequency, density of immature cedar elm trees, basal area per meter, and lateral-distance parameters. Although dbh values were significantly different, these two stands exhibited a remarkable degree of uniformity. This corresponded to the similarity of nearly identical values for sand, silt, and clay composition of A_1 and B_1 layers at the upper and lower Little Elm sites. These results confirmed field observations. Cedar elm trees of both Little Elm stands appeared to be high-density, high-frequency populations of smaller trees spaced evenly throughout the stand. Reproduction, as indicated by immature-tree density, appeared to be good.

CHAPTER V

CONCLUSIONS

Variations in populations of *Ulmus crassifolia* were observed in two stands along each of four creeks in Denton County, Texas. Although no single determining factor for the differences among cedar elm populations was found, several factors together may have influenced populations.

Destruction of streamside forest stands had reduced the number of populations of cedar elm and left some small, remnant areas bordering creeks. The upper Denton Creek stand and lower Clear Creek stand were evidently these remaining, inner portions of once-larger stands. The lower Denton Creek, upper Clear Creek, lower Elm Fork, and upper Elm Fork stands were large stands including not only an inner creek portion with large trees, but also a floodplain area extending some distance beyond the creek. The Little Elm stands were small stands of small trees immediately bordering the shallow streambed of Little Elm Creek. Little Elm stands were unique, in that no large trees were found further than a few meters from the creekbed, and stands resembled thickets of small, short, scrubby trees rather than the taller, more mature floodplain forests seen at other creeks.

Soil-particle size varied from stand to stand, but the high water table in the floodplain soils negated the concept of differing soil-particle size as an index of the water-holding capacity of the streamside soils.

Competition was seen to be an important factor in seedling establishment, with hackberry, soapberry, and red ash being dominant competitors. Extreme variation in both overall and cedar elm seedling numbers was attributed to differences in canopy cover, ground cover by forbs and grasses, and amount of localized grazing present within stands.

Dbh size-class distribution results demonstrated variance in age-classes present at each stand. The Little Elm Creek stands were seen as younger stands undergoing full-scale succession. The upper Elm Fork stand was an older stand undergoing succession in areas farthest from the creek. The lower Denton Creek stand was a fairly stable stand with good reproduction and representation in all age-classes. The upper Clear Creek stand was an older, mature stand with poor cedar elm reproduction, as was the lower Elm Fork stand. The lower Clear Creek and upper Denton Creek stands were older, remnant stands consisting of larger trees confined to small acreages.

Lumbering and cattle grazing were observed in several of the stands, but were not extensive or widespread in apparent damage. The continued removal of portions of stands has left remnant areas of older trees surrounded by agriculture. This destruction has strongly influenced cedar elm establishment.

In summary, this investigation demonstrated that cedar elm populations exhibited marked differences in population parameters at different study sites. No clear correlations of soil-particle size and population-parameter variations were determined. Seedling competition was an important factor in seedling establishment. Succession, grazing, and flooding were observed to exert localized influence on cedar elm trees present within the stands. The removal of stand areas for agricultural development was seen as an important factor in differences among stands.

APPENDIX

APPENDIX I

LOWER DENTON CREEK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	18.0	6.0 R	19.6
2	31.0	1.5 L	3.6
3	31.0	1.5 L	6.5
4	33.0	0.0	7.5
5	33.5	1.5 R	7.1
6	38.0	1.0 R	5.8
7	40.0	1.0 R	5.5
8	43.5	0.5 R	6.6
9	43.5	1.0 L	7.1
10	45.5	1.0 L	4.2
11	46.5	0.5 L	5.8
12	47.5	0.0	1.6
13	48.5	0.5 R	2.1
14	50.0	0.5 L	3.3
15	52.5	1.0 L	1.6
16	53.0	1.0 L	2.7
17	53.0	0.5 R	3.4
18	54.0	0.5 R	2.3
19	54.0	1.0 R	2.1
20	54.0	1.0 R	2.4
21	58.0	0.5 L	1.9
22	74.0	1.0 L	1.8
23	76.5	0.0	3.2
24	81.5	1.0 L	1.8
25	86.5	0.0	1.6
26	100.0	0.0	8.8
27	107.0	3.0 R	6.0
28	107.0	3.5 R	6.4
29	111.0	2.0 L	3.7
30	114.0	0.5 L	3.3
31	115.0	1.5 R	6.5
32	117.5	1.0 R	4.1
33	121.0	1.5 R	4.6
34	122.5	0.0	5.8
35	134.5	4.0 L	3.8
36	145.5	0.5 L	4.8
37	161.5	1.0 L	6.4
38	162.0	2.0 L	4.2
39	163.5	1.0 L	3.8
40	171.5	3.0 R	6.4

APPENDIX I - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
41	172.5	3.0 R	4.9
42	176.5	2.0 L	18.4
43	181.0	1.0 R	2.0
44	183.0	1.5 R	3.7
45	187.5	0.0	2.4
46	191.5	1.0 R	6.4
47	191.5	1.0 R	6.4
48	193.0	1.0 R	6.1
49	196.0	0.5 L	5.7
50	196.0	1.5 R	7.0
51	196.5	3.0 R	7.7
52	201.5	1.0 L	6.5
53	201.5	1.0 L	5.2
54	201.5	1.0 L	3.0
55	211.5	2.5 R	11.0
56	213.5	1.5 R	4.1
57	213.5	1.5 R	4.1
58	213.5	1.5 R	2.3
59	215.5	2.0 R	3.3
60	247.0	1.5 L	8.3
61	249.5	1.5 R	6.0
62	251.5	3.0 R	12.1
63	257.0	1.0 R	15.9
64	264.0	1.0 R	1.9
	. . .	. . .	2.3
65	265.0	1.0 R	3.1
66	265.0	1.5 R	3.0
67	290.0	1.0 R	3.9
68	313.0	0.0	2.7
69	313.0	0.0	5.5
70	313.0	0.0	5.2
71	333.0	0.0	11.8
72	333.0	0.0	11.4
73	334.0	0.5 R	13.0
74	336.0	2.0 R	12.8
75	351.0	1.0 R	9.6
76	352.0	0.5 R	12.8
77	354.5	1.5 R	11.3
78	356.5	1.5 L	16.2
79	360.5	1.5 R	13.6
80	360.5	1.5 R	13.2
	. . .	. . .	9.1

*= meters from base, **= meters from transect, ***=inches.

APPENDIX II

LOWER DENTON CREEK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	0.0	0.0	15.6
2	0.5	3.5 L	13.3
	. . .	. . .	15.3
3	5.5	1.5 R	5.6
4	8.5	0.5 L	4.9
5	8.5	1.0 R	4.9
6	18.5	3.5 L	14.7
7	21.5	3.5 L	8.1
8	36.5	3.5 L	15.1
9	37.0	3.0 R	15.3
10	45.0	2.0 R	11.6
11	46.0	1.0 L	5.3
12	55.0	0.0	3.4
13	56.0	3.0 L	9.5
14	60.0	1.0 L	8.6
15	62.0	0.0	6.0
	. . .	. . .	12.6
16	63.0	0.5 R	9.2
17	73.0	3.5 R	11.5
18	76.0	4.5 R	13.4
19	82.0	1.5 R	7.4
	. . .	. . .	11.5
20	91.0	2.0 L	10.9
21	92.0	1.0 L	1.5
22	112.0	2.0 R	7.2
23	129.0	1.5 R	7.9
24	133.0	2.5 R	5.5
25	140.5	0.0	8.5
26	146.5	2.0 L	14.3
27	166.5	0.0	9.4
28	170.5	1.0 R	16.2
29	173.5	0.0	2.9
30	179.5	0.5 R	17.1
31	179.5	0.5 L	15.2
32	182.0	3.0 L	11.6
33	186.5	2.0 L	11.1
34	198.5	1.0 R	1.6
35	210.5	1.0 L	5.6
	. . .	. . .	7.3
36	212.5	1.0 R	7.7
	. . .	. . .	4.2
37	215.0	0.0	5.0

APPENDIX II - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
38	215.0	0.0	5.3
39	219.0	0.0	4.3
40	222.0	1.0 R	4.9
41	224.0	1.0 R	3.8
42	228.5	1.0 L	4.0
43	229.0	0.0	6.0
44	229.0	1.0 L	6.0
45	229.5	0.5 L	4.2
46	231.5	0.0	2.4
47	232.0	1.0 L	3.5
48	234.0	0.5 R	5.4
49	236.0	1.0 R	5.2
50	236.0	1.0 R	4.1
51	243.0	0.0	4.7
52	245.0	0.0	7.1
53	248.5	0.5 R	8.3
54	249.0	0.5 R	5.4
55	251.0	1.0 R	5.5
56	251.0	1.0 L	5.2
57	252.0	1.0 L	3.7
58	252.0	2.0 R	6.0
	· · ·	· · ·	4.8
59	253.5	1.0 L	2.7
60	254.5	1.0 L	6.7
61	260.5	1.0 R	5.3
	· · ·	· · ·	7.6
62	262.5	0.0	3.8
	· · ·	· · ·	6.4
	· · ·	· · ·	6.7
	· · ·	· · ·	3.6
	· · ·	· · ·	3.9
63	264.5	1.0 R	3.4
64	271.5	1.0 L	7.3
	· · ·	· · ·	3.7
65	279.5	0.0	4.0
66	282.0	1.0 L	6.2
67	284.0	2.0 R	7.0
68	284.5	2.0 R	7.0
69	288.5	1.5 L	4.2
70	289.5	1.5 L	9.2
	· · ·	· · ·	7.5
71	293.5	0.5 R	4.1
72	293.5	0.5 R	2.7
73	293.5	0.5 L	3.4
74	293.5	1.0L	2.8

APPENDIX II - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
75	295.5	2.0 R	4.0
76	295.5	2.0 R	3.0
77	302.5	0.0	4.2
78	306.5	1.0 L	6.5
79	306.5	1.0 R	3.7
80	307.5	1.0 R	4.1
81	308.0	1.0 L	3.4
82	311.0	0.0	6.8
83	311.0	0.0	2.1
84	318.0	1.5 L	5.0
85	318.5	1.0 R	5.6
86	319.0	1.5 R	6.0
87	320.0	1.0 L	1.6
88	321.0	0.5 R	2.0
89	321.0	1.5 L	4.3
90	323.0	0.0	1.9
91	342.0	1.0 L	1.9
92	390.0	0.0	3.3
93	404.5	2.0 R	1.8
94	431.0	0.0	2.3
95	432.5	0.0	2.2
96	432.5	0.0	1.5
97	441.5	1.5 L	6.3
98	458.5	0.0	21.5
99	468.0	1.5 R	2.3
100	500.0	6.0 R	25.1
101	513.0	1.5 R	1.8
102	515.0	1.5 R	3.1
103	515.5	1.5 R	4.1
104	519.0	2.0 R	1.8
105	526.0	0.5 L	3.4
106	532.0	2.5 L	2.3
107	535.0	0.0	5.6
	. . .	. . .	3.1
108	540.0	0.0	11.0
109	542.0	1.0 L	9.5
110	547.0	2.5 R	4.1
111	552.0	1.0 R	5.7
112	556.0	3.5 R	8.3
113	560.0	0.0	4.5
	. . .	. . .	3.2
114	564.0	1.0 L	6.3
115	565.0	3.0 L	6.3
116	566.5	2.5 R	9.2
117	568.5	0.0	2.7

APPENDIX II - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
118	570.0	1.5 R	4.1
119	572.5	0.5 L	6.0
120	575.0	1.5 R	7.1
121	578.0	3.5 L	4.0
122	583.0	1.0 R	2.9
123	590.5	0.5 L	17.4
124	597.5	0.0	2.0
125	598.5	0.0	1.5
126	600.0	0.5 R	2.2
127	600.5	3.0 L	7.2
128	601.0	1.0 R	1.7
129	602.5	1.5 R	2.7
130	604.0	0.5 R	2.7
131	605.0	0.0	2.5
132	605.0	1.0 R	2.6
133	605.5	3.5 L	8.3
134	607.5	0.5 R	2.6
135	608.0	0.5 R	2.4
136	608.0	3.0 R	4.4
137	610.0	1.0 R	5.9
138	613.5	1.0 R	4.1
139	614.0	0.0	2.0
140	614.0	0.0	5.9
141	614.5	0.5 R	6.1
142	616.0	2.0 L	4.8
143	619.0	1.5 L	7.7
144	621.0	0.5 L	6.6
145	625.5	1.0 L	4.4
146	626.5	1.0 L	6.9
147	630.5	1.0 L	5.8
148	633.0	0.5 R	3.5
149	634.0	2.5 L	6.3
150	636.0	2.0 L	3.6
151	638.5	1.0 L	3.8
152	640.5	0.0	2.0
153	641.0	3.0 L	7.0
154	652.5	3.5 R	13.0
155	656.5	3.5 R	9.2
156	656.5	1.0 L	4.5
157	660.5	4.5 L	4.4
158	661.5	3.0 R	8.2
159	664.5	1.0 L	1.8
160	667.5	0.0	1.8
	. . .	. . .	2.2
161	667.5	0.0	2.2

APPENDIX II - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
162	673.0	1.0 L	3.9
163	681.0	0.0	10.3
164	682.5	0.0	7.0
165	686.0	0.5 R	4.2
166	703.5	0.0	2.0
167	707.0	0.0	1.6
168	707.0	1.0 R	2.8
169	708.5	0.5 L	1.6
170	709.5	0.0	5.1
171	710.5	0.0	2.2
172	710.5	1.0 R	3.3
173	712.5	1.0 L	1.8
174	715.5	1.5 L	2.2
175	718.5	1.0 L	3.4
176	725.5	1.0 L	7.2
177	731.0	0.0	5.7
178	734.0	1.5 L	3.5
179	735.0	1.0 L	7.7
180	736.0	0.5 R	2.3
181	736.0	0.0	2.3
182	738.0	1,0 L	4.8
183	745.0	1.0 L	5.4
184	750.0	2.0 L	6.0

*=meters from base, **=meters from transect, ***=inches.

APPENDIX III

UPPER DENTON CREEK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	62.0	3.5 L	23.1
2	90.0	0.0	1.8
3	105.0	0.5 R	2.2
4	108.0	0.5 R	1.5
5	109.5	0.0	2.0
6	110.5	1.0 R	1.9
7	111.5	0.5 L	1.5
8	120.0	3.5 L	22.5
9	121.0	3.0 R	4.7
10	132.0	0.5 L	2.8
11	133.0	0.5 R	3.7
12	140.0	1.0 L	3.4
13	142.0	3.0 L	4.6
14	143.0	1.0 R	4.7
15	144.0	0.5 L	6.7
16	148.0	3.5 R	10.2
17	149.5	3.5 R	14.9
18	150.0	1.0 L	10.4
19	151.0	1.0 L	5.0
20	170.0	1.0 R	2.1
21	180.0	2.5 R	6.1
22	182.0	0.0	6.8
23	182.0	1.5 R	5.4
24	184.0	1.5 R	7.5
25	207.0	4.0 R	18.9
26	215.0	1.0 R	7.0
27	228.0	1.5 L	5.8
28	251.0	0.0	6.3
29	251.0	1.0 R	15.3
30	252.0	1.5 L	8.0
31	256.0	2.0 R	10.8
32	257.5	1.5 R	4.2
33	259.5	0.0	12.0
34	270.5	4.0 L	13.5
35	274.5	2.5 L	12.5
36	278.5	3.0 L	10.7
37	281.0	1.5 R	9.2
38	282.0	2.0 R	10.4
39	309.0	1.0 L	10.9
40	310.0	1.5 R	14.4
41	323.0	2.0 L	14.8
42	323.0	2.5 R	13.8
43	328.0	4.0 R	12.7

APPENDIX III - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
44	334.0	3.0 L	10.1
45	335.5	1.5 L	5.0
46	340.5	2.5 R	12.0
47	352.5	1.5 L	4.6
48	370.0	2.5 L	9.6
49	378.0	2.5 R	23.2
50	382.0	2.5 R	21.8
51	384.0	0.0	6.4
52	389.0	2.5 R	3.8

*=meters from base, **=meters from transect, ***=inches.

APPENDIX IV

UPPER DENTON CREEK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	13.0	1.0 R	4.2
	. . .	. . .	2.1
2	14.0	1.5 L	1.5
3	15.0	2.0 L	2.4
4	16.0	3.0 R	4.0
5	16.0	1.5 L	2.7
6	17.0	0.0	2.4
7	17.0	3.0 R	8.6
8	18.0	2.0 R	2.9
9	20.5	2.5 R	8.3
10	21.5	1.0 L	1.5
11	22.5	2.0 R	3.9
12	29.5	0.5 L	3.3
13	30.0	1.5 L	6.3
14	34.5	0.0	1.8
15	37.0	0.5 L	4.5
16	40.0	1.0 L	3.5
17	42.0	1.0 L	2.8
18	48.0	0.0	16.6
19	64.0	4.0 L	16.6
20	67.5	5.0 R	21.3
21	69.0	0.5 R	2.9
22	87.0	2.0 L	9.4
23	102.0	1.5 L	16.3
24	112.0	2.0 R	9.2
25	119.0	0.0	15.9
26	131.0	2.0 R	15.0
27	139.0	1.5 R	9.2
28	150.0	1.0 R	3.2
29	171.0	2.0 L	2.4
30	183.0	0.0	18.6
31	196.0	2.5 R	13.8
32	197.0	6.0 L	17.5
33	202.0	0.0	13.9
34	203.5	1.5 R	13.2
35	209.5	2.0 L	15.1
36	215.5	4.0 R	22.9
37	217.5	4.5 L	10.7
38	224.5	3.0 L	10.5
39	224.5	4.0 R	19.4
40	232.5	3.5 R	12.0
41	232.5	3.0 L	8.1
42	233.5	2.0 L	11.8

APPENDIX IV - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
43	238.5	4.0 L	16.1
44	243.5	6.0 L	17.9
45	245.5	4.0 L	10.9
46	250.5	0.0	12.2
47	254.5	3.5 R	11.1
48	255.5	2.0 L	9.7
49	256.0	0.0	5.5
50	256.5	1.5 R	7.1
51	261.0	3.0 L	10.1
52	262.0	2.5 R	6.3
53	267.0	2.0 L	11.7
54	293.0	3.0 R	15.4
55	298.0	2.0 L	17.4
56	370.0	0.0	4.7
57	373.0	1.0 L	8.1
58	386.0	6.0 R	17.8

*=meters from base, **=meters from transect, ***=inches.

APPENDIX V

LOWER CLEAR CREEK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	5.5	5.0 R	16.5
2	27.5	1.0 R	3.3
3	31.0	4.0 R	5.2
4	48.5	1.0 L	5.5
5	57.5	0.0	11.0
6	70.5	3.5 R	10.2
7	72.5	4.5 R	12.5
8	89.5	1.0 L	3.2
9	89.5	1.0 L	3.8
10	98.5	4.0 L	9.0
11	150.0	1.5 L	3.2
12	154.0	2.5 R	6.3
13	175.0	2.0 R	10.3
14	189.0	4.0 R	13.4
15	191.5	5.5 R	12.1
16	197.5	3.5 L	9.4
17	200.0	1.5 R	5.3
18	205.5	2.0 R	11.7
19	209.5	1.5 R	12.9
20	224.5	2.0 R	6.1
21	226.0	2.0 R	15.0
22	227.0	5.5 L	14.5
23	238.0	1.5 R	12.8
24	240.0	3.0 R	8.7
25	240.5	5.0 L	10.1
26	242.0	0.5 L	12.5
27	245.0	3.0 R	6.4
28	247.5	0.0	2.4
29	248.0	2.5 L	10.5
	. . .	. . .	4.6
30	256.0	1.0 L	7.2
31	261.0	0.0	3.4

*=meters from base, **=meters from transect, ***=inches.

APPENDIX VI

LOWER CLEAR CREEK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	39.5	5.0 L	12.5
2	67.5	2.0 L	12.1
3	111.5	1.0 L	13.8
4	127.5	2.0 R	12.8
5	160.5	0.0	9.6
6	167.0	0.5 L	3.0
7	179.0	3.0 R	10.4
8	237.5	2.5 R	9.8
	. . .	. . .	4.6
9	244.5	6.5 R	24.5
10	246.5	2.5 R	5.0
11	251.5	0.0	2.4
12	255.5	1.0 L	3.1

*=meters from base, **=meters from transect, ***=inches.

APPENDIX VII

UPPER CLEAR CREEK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	11.5	0.0	6.2
2	11.5	0.0	17.3
3	18.0	2.0 L	11.6
	. . .	. . .	12.0
4	25.0	2.0 R	5.1
5	28.0	1.0 L	8.3
6	28.0	1.0 L	3.8
7	29.0	0.5 R	10.2
8	32.0	0.0	7.8
9	34.0	0.5 L	3.9
10	34.0	0.5 R	3.7
11	37.0	1.0 L	2.9
12	37.0	3.0 L	8.6
13	42.0	2.0 L	7.1
14	43.0	2.5 R	5.8
15	44.0	0.5 L	9.7
16	54.0	0.0	4.5
17	54.0	0.5 L	5.5
18	59.0	1.0 R	4.3
19	63.0	1.0 R	3.3
20	63.0	2.0 L	9.6
21	69.0	2.0 L	6.6
22	72.0	2.0 L	9.7
23	75.0	1.0 R	5.3
24	89.0	0.5 L	2.1
25	96.0	4.0 L	6.0
26	102.0	0.0	3.3
27	158.5	1.5 L	29.8
28	166.5	0.0	1.5
29	167.0	1.0 L	2.2
30	192.0	1.0 L	2.3
31	202.0	2.5 L	9.8
32	208.0	2.0 R	8.3
33	216.0	1.5 R	10.0
34	225.0	2.0 L	9.3
35	239.0	1.0 L	2.3
36	259.0	1.0 R	2.2

*=meters from base, **=meters from transect, ***=inches.

APPENDIX VIII

UPPER CLEAR CREEK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	12.5	1.5 R	2.2
2	25.5	3.5 L	9.3
3	30.5	2.0 R	3.4
4	41.5	0.0	6.9
5	60.5	2.0 L	6.4
6	77.5	2.0 R	12.0
7	81.0	4.0 L	13.9
8	88.0	3.0 L	5.4
9	95.0	3.0 R	10.2
10	96.0	2.5 L	13.2
11	100.0	4.0 R	15.5
12	108.0	1.0 R	4.3
13	113.0	0.0	15.3
14	121.0	0.0	2.4
15	140.0	4.5 L	18.0
16	148.0	4.0 L	13.8
17	174.0	2.5 L	11.7
18	185.0	1.5 L	6.3
19	194.0	1.0 R	3.0
20	201.0	1.5 L	13.4
21	227.0	0.0	17.9
22	237.0	0.0	18.0
23	242.0	3.0 L	16.5
24	284.0	2.0 R	18.7
25	296.0	2.0 R	14.0
26	300.0	3.0 R	15.2
27	305.0	3.5 R	19.5
28	318.0	1.0 R	5.7
29	336.5	1.0 R	9.3
30	338.0	3.5 L	15.8
31	342.0	1.5 L	10.2
32	344.5	1.0 R	16.0
33	348.0	4.0 R	7.8
34	367.0	4.5 L	18.0
	. . .	. . .	12.7
35	389.5	1.0 L	9.0
36	389.5	1.0 R	9.5
37	392.0	2.0 R	6.5
38	396.5	0.0	12.0
39	403.5	2.5 R	10.5
40	407.5	0.0	7.7
41	408.5	1.5 L	7.3
42	416.5	2.0 L	7.6

APPENDIX VIII - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
43	418.5	2.0 R	5.1
44	421.5	0.0	6.1
45	430.0	0.5 R	6.7
46	431.5	1.0 L	6.8
47	433.0	1.0 R	4.0
48	434.0	1.5 R	3.9
49	434.0	1.0 L	5.7
50	436.0	2.0 R	5.9
51	442.0	0.0	5.0
	. . .	. . .	1.6
52	446.0	1.0 L	3.3
53	451.5	0.0	8.2
54	453.0	1.5 L	5.1
55	459.5	1.0 R	6.6
56	463.0	1.0 R	5.3
57	464.0	1.0 L	6.8
58	464.5	1.5 R	4.3
59	466.5	0.5 R	7.9
60	468.0	1.0 L	4.4
61	470.5	7.0 R	5.0
62	475.0	0.5 L	3.0
63	475.5	1.0 R	3.6
64	477.5	0.5 L	6.5
65	489.5	2.0 R	16.5
66	494.5	1.5 L	17.0
67	507.5	1.5 L	5.1
68	515.5	0.5 R	27.5
69	519.0	3.0 L	14.0
70	522.5	0.5 R	17.0
71	527.5	3.0 R	16.3
72	536.5	5.5 R	17.5
73	542.5	3.0 R	13.5
74	543.5	3.0 L	18.7
75	549.5	4.5 R	18.5
76	553.5	3.5 L	18.5
77	563.5	0.5 L	15.7
78	571.0	3.0 R	20.6

*=meters from base, **=meters from transect, ***=inches.

APPENDIX IX

LOWER ELM FORK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	11.0	1.0 L	2.4
2	29.0	0.0	14.2
3	33.5	0.0	11.6
4	39.5	2.0 L	7.3
5	49.5	1.0 L	5.4
6	63.5	0.0	3.2
7	71.5	1.0 L	4.5
8	113.5	0.0	2.2
9	137.5	2.0 L	14.2
10	149.5	2.0 R	3.3
11	162.5	2.0 R	12.1
12	173.5	2.0 L	17.8
13	187.0	2.0 L	5.9
14	191.0	1.5 L	16.5
	. . .	. . .	4.1
15	195.0	2.0 L	3.7
16	199.0	0.0	11.0
17	202.0	2.0 L	5.0
18	204.0	2.5 R	6.8
19	212.0	1.0 R	3.5
20	215.0	0.0	4.9
21	216.5	1.5 L	4.3
22	216.5	1.0 R	2.4
23	217.5	2.0 R	3.1
24	219.5	0.0	3.0
25	219.5	3.0 R	6.9
26	223.5	5.5 L	19.4
27	238.5	1.5 R	6.5
28	242.5	1.0 R	7.3
29	261.5	1.0 R	13.7
30	275.0	6.0 L	15.3
31	288.0	0.5 L	15.4
32	298.0	3.5 L	16.0
33	308.0	5.0 L	15.9
34	325.0	2.0 R	15.4
35	350.0	0.0	2.9
36	351.0	1.0 R	7.4
37	359.0	2.5 L	3.8
38	363.0	1.0 L	2.2
39	365.0	1.0 L	1.9
40	373.0	3.0 R	14.6
41	393.0	1.0 L	1.7
42	397.0	0.0	11.0

APPENDIX IX - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
43	400.0	1.0 L	11.9
44	409.0	3.0 L	15.1
45	421.0	3.0 L	17.4
46	441.0	3.0 L	13.0

*=meters from base, **=meters from transect, ***=inches.

APPENDIX X

LOWER ELM FORK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	9.0	0.5 L	12.2
2	19.0	1.5 R	4.2
3	22.0	1.5 R	5.8
4	23.5	1.0 R	4.3
5	32.5	2.0 L	2.3
6	34.0	2.0 L	7.1
	. . .	. . .	3.0
7	35.0	1.0 R	7.6
8	39.0	0.5 L	4.7
9	41.5	0.5 R	5.0
10	41.5	0.5 R	3.7
11	47.5	3.0 L	6.8
12	54.5	2.5 R	8.0
	. . .	. . .	3.0
	. . .	. . .	5.5
13	57.5	0.0	4.6
	. . .	. . .	4.7
14	59.5	1.5 L	4.3
	. . .	. . .	2.5
	. . .	. . .	4.5
	. . .	. . .	3.0
	. . .	. . .	8.3
15	64.0	3.0 R	8.7
16	67.0	0.0	2.7
17	67.0	0.5 L	5.1
18	68.5	0.5 R	5.2
19	71.5	1.5 R	6.1
20	74.5	1.5 L	11.3
21	81.5	2.0 L	4.9
	. . .	. . .	7.2
22	82.5	2.5 L	8.1
23	88.5	0.0	8.9
24	93.0	1.5 L	7.0
	. . .	. . .	6.4
25	96.0	2.5 L	11.9
26	99.5	1.5 R	13.4
27	105.0	1.5 L	8.2
28	106.5	0.0	4.3
	. . .	. . .	10.0
29	108.5	1.5 L	7.3
	. . .	. . .	2.3
30	108.5	1.5 L	7.2

APPENDIX X - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
31	114.5	2.0 L	5.8
32	114.5	2.0 L	7.1
33	141.5	0.0	8.4
34	146.0	2.0 L	5.3
35	216.0	0.0	3.1
36	252.0	1.0 R	4.3
37	257.0	1.0 L	3.5
	. . .	. . .	4.1
38	295.0	1.5 R	5.5
39	301.0	1.5 L	4.5
40	305.0	1.5 L	6.3
41	315.0	0.0	11.7
42	318.0	3.0 R	10.3
	. . .	. . .	7.1
43	321.0	1.5 L	9.8
44	322.0	2.0 L	13.5
45	327.0	2.0 R	16.4
46	330.0	0.0	10.6
47	339.0	0.0	11.8
48	344.5	2.0 L	15.3
49	356.5	2.0 L	15.4
	. . .	. . .	5.1
50	358.0	3.0 R	10.6
51	362.0	3.0 L	15.7
52	367.0	1.5 L	12.0
53	376.0	0.0	13.6
54	381.0	0.0	11.4
55	384.0	0.0	5.2
56	388.0	2.0 R	14.4
57	391.5	1.0 L	11.0
58	399.0	1.0 L	10.8
59	400.0	4.0 R	15.1
60	415.0	3.5 R	9.0
61	416.0	3.0 L	13.3
62	428.0	3.0 L	12.3
63	430.0	3.0 L	11.9
64	434.0	3.5 L	11.7
	. . .	. . .	9.1
65	434.0	3.5 R	15.7
66	443.0	3.0 L	18.5
67	446.0	1.0 R	11.1
68	451.0	1.5 R	8.5
69	456.0	3.0 L	9.7
70	456.0	3.0 R	13.7
71	467.0	0.0	10.5

APPENDIX X - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
72	470.0	2.0 L	15.8
73	473.5	2.0 L	11.9
74	480.5	3.0 L	15.8
75	484.5	2.0 R	13.0
76	505.5	0.0	17.3
77	507.5	3.0 L	15.1
78	512.5	0.0	7.5
79	512.5	2.0 L	10.6
80	512.5	3.5 R	12.6
81	524.5	0.0	12.1
82	528.0	0.0	10.4
83	537.5	0.0	13.6
84	544.5	2.0 R	5.0
85	545.5	2.5 R	8.7
86	546.5	0.0	5.7
87	547.0	0.5 R	3.9
88	554.0	1.5 R	7.9
89	586.0	0.0	17.5

=meters from transect, *=meters from base, *=inches.

APPENDIX XI

UPPER ELM FORK STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	30.0	6.0 L	11.1
	. . .	. . .	4.3
2	292.0	1.5 L	2.6
3	303.0	0.0	4.0
4	308.0	2.0 R	2.9
5	310.0	2.0 R	6.8
6	330.0	0.0	5.2
7	332.5	0.5 R	2.1
8	338.5	1.0 L	1.7
9	338.5	0.5 L	1.8
10	341.5	0.0	2.3
11	342.5	0.5 R	1.7
12	343.5	1.0 L	2.4
13	343.5	1.0 L	2.8
14	346.0	1.0 R	2.3
15	347.0	1.5 L	1.7
16	349.0	0.5 L	2.5
17	352.0	0.0	1.5
18	352.5	0.5 R	1.7
19	363.5	1.0 R	3.8
20	367.5	1.0 R	2.4
	. . .	. . .	2.3
	. . .	. . .	4.1
21	369.5	4.5 R	22.2
22	394.5	0.0	1.7
23	413.5	1.0 R	2.2
24	426.0	0.5 L	3.3
25	435.5	1.0 R	1.7
26	451.5	0.0	2.3
27	459.0	0.0	3.2
28	461.0	0.5 R	4.1
29	464.5	0.5 R	1.5
30	474.0	0.0	1.8
31	477.0	0.0	2.9
32	479.0	0.5 R	3.0
33	479.0	0.5 L	6.6
34	480.0	0.5 L	4.1
35	480.5	0.5 L	4.4
36	482.5	0.0	4.8
37	483.5	2.0 R	7.6
38	485.5	0.5 R	1.8
39	485.5	2.5 R	6.7
40	486.5	1.0 L	2.0

APPENDIX XI - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
41	490.5	0.0	3.0
42	491.0	0.0	4.4
43	494.0	1.0 R	1.6
44	499.5	1.0 R	1.8
45	504.0	0.0	7.7

*=meters from base, **=meters from transect, ***=inches.

APPENDIX XII

UPPER ELM FORK STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	53.0	1.0 L	3.3
2	111.5	1.0 R	3.2
3	173.0	2.5 L	7.2
4	177.0	2.0 L	1.7
5	187.0	1.0 R	2.7
6	193.0	1.0 R	2.5
7	244.0	1.0 R	3.4
8	250.0	1.0 L	2.0
9	257.0	1.0 R	2.7
10	263.0	1.0 R	3.1
11	270.0	1.5 R	3.7
12	277.5	1.5 R	3.8
13	407.5	0.0	2.4
14	411.0	2.0 R	9.0
15	413.0	0.0	6.4
16	414.0	1.0 L	3.0
17	415.5	1.0 L	4.0
18	416.0	1.0 L	6.0
19	418.5	2.0 R	8.4
20	419.5	2.5 R	8.7
21	422.0	1.0 L	4.7
22	422.5	0.0	5.3
23	425.0	1.5 L	3.2
24	428.0	1.5 R	13.0
25	430.0	3.0 L	14.1
26	434.0	1.0 R	1.7
27	437.0	0.5 L	3.2
28	438.0	0.5 L	4.5
29	440.0	1.0 L	2.6
30	443.0	1.5 R	3.5
31	448.0	2.0 R	16.0
32	451.0	1.0 L	3.1
33	458.0	2.5 R	17.3
34	462.0	1.5 L	1.6
35	468.0	1.5 L	3.6
36	476.0	1.5 L	3.8
37	479.0	3.0 R	18.0
38	484.5	0.5 R	3.2
	. . .	. . .	3.4
	. . .	. . .	2.4
39	484.5	0.5 L	7.3
40	486.5	0.0	5.0
41	486.5	0.0	2.0

APPENDIX XII - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
42	495.5	3.5 L	9.0
43	496.5	1.5 R	10.1
44	499.5	3.0 R	9.5
45	504.5	0.0	6.3
46	515.5	1.0 R	5.3
47	515.5	0.5 R	4.0
48	519.5	1.0 R	1.6
49	521.5	3.0 L	6.4
50	537.5	1.0 R	1.7
51	541.0	1.0 R	2.0

*=meters from base, **=meters from transect, ***=inches.

APPENDIX XIII

LOWER LITTLE ELM STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	3.0	0.5 R	8.5
2	6.0	2.0 R	11.1
3	14.0	1.5 L	3.9
4	14.0	3.0 R	6.8
5	22.0	1.0 L	10.2
6	24.0	0.5 R	2.5
7	24.0	2.5 L	8.4
8	26.0	1.5 R	7.0
9	26.0	2.0 L	5.8
10	33.0	2.0 R	11.0
11	35.5	1.0 R	6.8
	. . .	. . .	5.4
12	38.0	2.0 L	6.8
13	40.5	1.5 R	4.5
14	45.5	3.0 L	8.2
15	51.0	0.0	7.9
	. . .	. . .	3.0
16	52.0	0.5 L	3.2
17	56.0	0.0	6.6
18	61.5	0.0	5.4
19	63.5	0.5 L	9.0
20	75.5	0.0	7.8
21	76.5	2.0 L	6.2
22	80.0	1.0 L	6.2
23	81.5	0.0	3.8
24	84.5	2.5 L	3.5
25	84.5	2.5 L	7.3
26	92.0	1.5 R	7.3
27	95.0	0.0	12.3
28	96.0	0.5 L	4.7
29	99.5	1.5 R	5.9
30	100.5	0.0	1.8
31	100.5	0.0	3.5
32	104.5	2.5 L	2.2
33	104.5	2.5 L	2.6
34	106.0	1.0 R	1.9
35	108.0	1.0 R	4.0
36	108.0	1.0 R	6.7
37	108.5	0.5 R	5.1
38	109.5	0.5 R	3.9
39	111.0	0.5 R	7.5
40	113.5	0.5 R	6.7
41	121.0	0.5 L	5.1

APPENDIX XIII - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
42	122.5	1.0 L	7.9
43	126.0	0.5 R	2.5
44	127.5	1.0 R	2.5
45	128.5	0.0	2.2
46	129.0	0.0	5.5
47	130.0	0.5 R	3.3
48	130.0	0.5 L	4.4
49	130.5	0.5 R	4.9
50	131.0	1.0 L	3.7
51	132.0	0.5 R	4.6
	. . .	. . .	2.8
52	133.0	1.5 L	5.3
53	134.0	1.0 L	5.2
54	134.0	0.5 R	3.4
55	137.0	3.0 L	1.7
56	137.0	3.0 L	1.5
57	137.5	2.0 L	2.3
58	139.0	0.5 R	2.3
59	144.0	0.5 R	4.7
60	144.0	0.5 L	4.4
61	144.5	1.0 R	5.3
62	144.5	0.5 L	3.5
63	150.5	0.5 L	2.2
64	150.5	1.0 L	4.6
65	151.0	0.5 L	3.3
66	152.0	1.0 L	3.6
67	153.5	0.5 R	1.7
68	161.5	0.0	12.5
69	166.0	0.0	4.7
70	166.0	0.0	2.8
	. . .	. . .	1.5
71	171.0	1.5 R	4.8
72	177.0	0.5 L	3.8
73	185.0	1.0 L	3.6
74	186.5	0.5 R	4.3
	. . .	. . .	3.3
75	187.5	0.0	6.1
76	197.5	0.0	3.1
77	197.5	0.0	2.4
78	198.5	0.5 L	9.3
79	200.0	1.5 R	3.0
80	201.0	0.0	2.8
81	203.0	0.5 L	7.9
82	203.5	1.5 L	5.6
83	204.5	1.0 R	3.6

APPENDIX XIII - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
84	207.0	0.5 R	2.8
85	207.0	1.5 L	6.3
86	207.5	3.0 L	7.5
87	209.5	1.5 R	8.5
88	209.5	1.5 R	4.0
89	209.5	1.5 L	2.1
90	210.5	1.5 L	3.5
91	215.0	1.0 R	1.8
92	215.0	1.0 R	7.4
93	217.0	1.0 R	5.3
94	217.0	1.0 R	5.6
95	217.5	1.0 L	7.4
96	218.5	1.5 R	3.8
97	219.0	1.0 L	6.5
98	219.5	1.0 L	4.6
99	220.5	0.5 R	1.6
100	225.5	1.0 L	3.5
101	229.5	1.0 L	3.7
102	229.5	0.5 R	4.5
103	231.5	2.0 L	6.8
104	232.0	1.5 L	1.8
105	234.5	1.5 R	4.9
106	238.5	0.0	4.7
107	241.5	0.0	2.4
108	246.0	0.0	2.4
109	247.0	0.0	4.7
110	250.0	1.0 L	5.1
111	270.0	1.5 L	3.6
112	271.5	0.0	5.5
113	271.5	0.0	6.0
114	275.0	2.0 L	5.6
115	278.0	1.5 L	1.6
116	283.0	0.5 L	5.0
117	295.0	1.0 R	10.8
118	296.5	1.0 L	13.1
119	305.5	1.5 L	9.4
120	306.5	1.0 L	6.6
121	308.5	0.0	8.2
122	308.5	0.0	6.2
123	311.5	0.5 L	8.3
124	315.5	1.0 L	8.3
125	316.5	1.5 R	7.2
126	320.5	3.0 R	8.4

*=meters from base, **=meters from transect, ***=inches.

APPENDIX XIV

LOWER LITTLE ELM STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	15.0	1.5 R	8.9
2	15.0	0.5 L	2.5
3	17.5	1.0 R	1.7
4	18.0	0.5 L	1.5
5	20.0	1.0 R	2.9
6	23.5	0.5 R	7.8
	. . .	. . .	7.8
7	24.5	0.5 L	1.5
8	32.5	1.5 R	12.2
9	36.5	2.0 R	7.6
10	40.5	0.5 R	7.4
11	42.0	0.0	2.2
12	44.5	1.0 L	3.7
13	44.5	1.0 R	6.0
14	47.5	0.0	3.8
15	48.0	0.5 L	6.2
16	48.0	0.5 L	5.5
17	51.0	1.5 L	4.8
18	51.0	1.5 L	7.8
19	59.0	0.0	7.4
20	61.0	0.0	1.9
21	61.0	0.0	3.0
22	64.0	0.0	3.8
23	70.0	3.0 R	3.1
24	73.0	3.0 R	6.3
25	78.0	3.0 R	10.1
26	84.0	0.5 R	1.8
27	89.0	0.0	2.0
28	93.5	0.5 R	7.1
29	94.0	0.0	6.3
30	97.0	0.5 L	10.6
31	102.5	0.5 L	7.3
32	102.5	3.0 L	8.3
33	105.5	1.0 R	9.7
34	105.5	2.0 L	4.7
35	107.0	0.0	1.7
36	107.5	1.5 L	6.3
37	109.5	1.0 L	6.0
38	110.5	2.0 R	2.5
39	111.0	0.0	3.0
40	111.5	0.0	9.3
41	113.0	0.5 L	4.5
42	114.0	1.0 R	3.5

APPENDIX XIV - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
43	116.0	1.0 R	5.3
44	122.5	1.5 R	16.1
45	129.5	1.0 R	11.9
46	129.5	6.0 L	18.9
47	133.5	1.5 R	8.1
48	139.5	0.0	5.8
49	142.5	1.5 L	6.1
50	143.5	1.0 R	3.1
51	147.5	1.0 L	6.9
52	150.5	1.0 L	4.9
53	150.5	6.5 R	15.1
54	157.5	1.5 L	10.5
55	161.0	1.0 R	2.9
56	163.0	0.5 R	16.2
57	170.0	0.0	4.8
58	172.0	1.5 L	7.0
59	172.5	0.5 R	5.5
60	173.5	0.0	3.2
61	173.5	1.5 L	4.0
62	176.5	2.0 L	2.6
63	186.5	2.0 L	6.3
64	190.5	1.0 R	4.9
65	191.0	2.0 L	6.9
66	201.0	4.0 R	13.0
67	212.5	1.0 L	7.8
68	212.5	0.5 L	2.9
69	213.0	1.0 R	8.0
70	213.5	1.5 R	11.7
71	220.5	2.0 R	3.6
72	223.0	1.0 R	5.1
73	227.0	4.0 L	4.8
74	238.0	1.5 L	5.3
75	246.5	0.0	14.0
76	264.5	4.5 L	6.5
77	267.5	0.0	8.4

*=meters from base, **=meters from transect, ***=inches.

APPENDIX XV

UPPER LITTLE ELM STAND - TRANSECT A

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	0.5	0.0	11.0
2	4.0	0.5 L	3.0
3	5.5	0.0	2.5
4	6.5	0.0	2.8
5	6.5	1.0 R	6.2
6	8.0	1.0 R	3.7
7	9.0	1.0 R	5.9
8	9.5	0.0	4.6
9	10.0	0.5 L	1.7
10	10.5	0.5 R	3.2
11	11.5	0.0	3.3
12	13.0	1.0 R	2.8
13	14.5	0.0	2.5
14	14.5	0.0	3.5
15	14.5	0.0	1.7
16	16.5	0.0	2.9
17	18.5	1.0 L	3.3
	. . .	. . .	1.9
18	20.5	1.0 L	2.3
19	22.5	0.5 L	8.2
20	22.5	2.0 R	5.0
21	25.0	0.5 R	3.6
22	25.0	0.5 L	5.9
23	26.0	1.0 L	4.1
24	28.0	1.0 R	9.9
25	30.5	1.0 R	8.9
26	32.5	1.0 L	2.6
27	34.0	1.0 L	5.1
28	38.0	1.0 R	2.3
29	38.0	1.0 L	2.6
30	40.5	2.0 L	4.4
31	45.5	2.5 L	9.4
	. . .	. . .	7.8
32	49.5	0.0	2.4
33	49.5	0.0	4.1
34	50.0	1.5 R	5.9
35	50.5	1.5 R	4.2
36	54.5	2.5 R	3.4
	. . .	. . .	4.6
37	58.5	4.0 R	5.8
38	59.5	4.0 R	9.9

APPENDIX XV - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
39	64.0	1.5 L	3.4
	. . .	. . .	2.4
40	64.0	2.0 R	1.9
41	68.5	1.0 R	2.4
42	69.0	1.0 R	2.2
43	98.0	3.0 R	8.0
44	101.5	3.0 R	5.3
45	106.0	2.0 R	5.2
46	125.0	2.0 R	7.3
47	137.0	0.5 R	6.1
48	138.5	0.5 R	5.7
49	141.5	0.0	6.0
50	146.5	0.0	3.4
51	146.5	1.5 R	4.6
52	148.0	1.0 L	5.1
53	154.0	1.0 L	10.5
	. . .	. . .	11.2
54	158.0	0.0	3.0
55	159.0	1.5 L	4.6
56	172.0	0.0	5.8
57	176.0	0.5 L	8.7
58	176.0	0.5 L	6.0
59	176.5	0.0	7.2
60	176.5	0.5 R	5.4
	. . .	. . .	5.6
61	179.5	0.0	3.8
62	181.5	0.0	4.6
63	183.0	0.0	3.2
64	186.0	0.0	1.8
65	186.5	0.5 L	3.4
66	187.0	0.5 L	3.4
67	189.0	0.5 L	2.1
68	189.0	0.5 R	5.0
69	190.0	0.0	4.3
70	191.0	0.5 R	2.0
71	191.5	0.5 R	1.6
72	191.5	1.0 L	5.4
73	200.5	0.0	4.0
74	202.5	1.0 L	11.8
75	204.5	1.0 L	3.0
76	206.5	2.0 L	5.6
77	207.0	2.0 L	4.1
78	210.0	1.5 L	2.6
79	211.0	1.0 L	1.5
80	211.0	1.5 L	4.5

APPENDIX XV - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
81	212.0	1.0 L	2.0
82	214.0	1.0 L	7.9
83	217.0	0.5 R	4.1
84	217.0	1.0 L	7.0
85	221.0	1.5 R	5.3
86	222.5	0.5 R	7.3
87	222.5	0.5 L	6.2
88	224.0	0.5 R	6.2
89	226.0	1.0 L	2.4
90	226.0	1.0 L	5.2
91	229.0	1.0 L	5.3
92	231.5	0.5 R	3.8
93	231.5	2.0 R	10.4
94	233.0	0.0	2.0
95	235.0	1.0 R	7.6
96	238.0	0.0	2.0
97	241.0	2.5 L	11.7
98	242.0	0.5 L	2.4
99	242.5	0.5 R	2.1
100	244.5	0.0	4.6
101	246.5	0.5 R	4.2
102	246.5	0.5 R	2.2
103	248.0	0.0	3.6
	. . .	. . .	4.9
104	249.5	0.5 L	2.9
105	254.0	2.0 R	5.9
106	254.0	2.0 R	6.5
107	256.0	2.0 R	3.9
108	258.0	1.5 R	2.9
109	270.0	1.5 R	2.3
110	270.0	1.5 L	3.4
111	274.0	1.0 L	3.6
	. . .	. . .	4.2
112	274.0	0.5 R	1.9
113	280.0	0.5 R	2.4
114	280.0	0.5 R	2.4
115	280.0	0.5 R	2.3
116	281.0	0.5 R	3.3
117	281.0	0.5 L	2.2
118	282.0	0.5 R	3.1
119	283.0	0.5 L	2.0
120	285.0	0.5 L	3.6
121	285.0	0.5 L	3.2
122	285.0	0.5 L	1.8
123	291.0	1.5 L	5.9

APPENDIX XV - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
124	297.0	0.5 L	5.5
125	297.0	0.5 L	2.3
126	297.0	0.5 L	4.1
127	297.0	0.5 L	2.4
128	297.0	0.5 L	3.5
129	303.0	1.5 L	4.2
	. . .	. . .	3.7
	. . .	. . .	3.4
130	304.0	2.0 L	4.3
131	317.0	1.0 R	2.6
132	319.0	0.0	2.1
133	321.5	0.0	3.8
134	323.0	0.0	2.5
135	323.0	0.0	1.6
136	325.0	0.0	2.4
137	327.5	0.0	2.2
138	331.5	0.0	1.7
139	336.5	0.0	2.6
140	336.5	0.0	1.9
141	339.5	0.0	4.2
142	339.5	0.0	6.5
143	345.5	2.0 R	3.4
144	349.5	0.0	3.1

*=meters from base, **=meters from transect, ***=inches

APPENDIX XVI

UPPER LITTLE ELM STAND - TRANSECT B

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
1	3.0	0.0	2.1
2	3.5	0.5 R	3.3
3	4.5	1.0 R	1.9
4	4.5	1.0 R	3.5
5	5.5	2.0 L	8.7
6	7.5	0.0	2.2
7	10.0	0.0	3.9
8	10.0	0.0	4.2
9	12.0	1.0 R	2.3
10	14.0	1.5 R	7.3
11	15.0	1.5 R	8.3
12	18.0	1.0 L	7.0
13	18.5	1.0 L	8.5
14	19.0	0.0	2.7
15	19.0	1.0 R	5.6
16	20.5	2.0 R	4.3
17	28.5	1.5 R	8.2
18	37.5	0.0	4.0
19	37.5	0.0	6.4
20	38.5	1.0 R	3.0
21	40.0	2.0 R	4.9
	. . .	. . .	4.8
22	41.5	1.5 L	6.1
23	44.0	0.0	10.4
24	56.0	1.0 L	7.9
25	57.5	0.0	10.1
26	58.5	1.0 L	7.6
27	58.5	0.0	4.8
28	58.5	0.0	5.1
29	59.5	0.5 L	6.1
30	61.0	2.0 L	5.7
31	73.0	2.0 L	10.7
32	76.0	2.5 L	6.1
33	80.0	2.0 R	9.9
34	86.0	1.5 R	6.0
35	86.0	1.5 L	10.2
36	91.0	0.0	10.0
37	95.0	1.5 L	6.3
38	95.0	2.0 L	12.4
39	95.0	1.5 R	10.0
40	99.0	0.5 R	10.6
41	102.5	1.5 R	5.2
42	102.5	2.0 L	9.7

APPENDIX XVI - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
43	106.5	1.5 L	3.7
44	108.0	0.0	9.0
45	108.0	1.0 R	3.1
46	108.0	0.5 R	7.4
	. . .	. . .	6.2
47	109.0	2.0 R	4.0
48	110.0	2.0 R	2.2
49	112.0	2.0 L	8.2
50	115.0	0.5 L	1.7
51	115.0	1.0 R	6.5
52	117.0	0.5 R	3.3
53	117.0	1.0 L	8.3
54	119.0	2.0 L	8.8
55	120.0	1.0 L	5.6
56	120.0	1.0 R	9.0
57	122.5	0.0	5.6
58	122.5	0.5 R	7.3
59	124.5	0.0	2.1
60	126.0	0.5 R	3.0
61	128.0	0.0	1.8
62	130.5	1.5 L	4.7
63	132.5	0.0	3.1
64	135.0	0.5 L	5.4
65	135.5	0.5 R	5.2
66	139.0	0.5 R	3.6
67	141.0	0.0	4.2
68	144.5	0.5 L	2.7
69	163.0	1.0 L	8.3
70	171.5	2.0 L	6.9
71	172.5	0.5 R	4.2
72	173.5	0.0	1.5
73	173.5	0.5 R	4.5
74	173.5	0.5 R	3.2
75	173.5	0.5 L	4.6
76	173.5	0.5 L	4.9
77	175.5	1.5 R	4.9
78	176.0	1.0 R	2.5
79	176.0	1.0 L	2.8
80	178.0	0.0	7.0
81	179.5	0.5 L	3.7
82	180.0	0.0	7.6
83	182.0	0.5 L	4.5
84	184.0	1.0 R	3.7
85	184.0	1.0 R	2.2
86	185.5	0.0	5.1

APPENDIX XVI - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
87	191.5	1.5 L	3.5
88	193.5	0.5 L	3.1
89	194.5	0.5 R	6.7
90	194.5	0.0	3.3
	. . .	. . .	4.2
91	201.5	2.0 L	4.8
92	202.5	0.0	3.4
93	203.0	0.0	3.4
94	203.0	0.0	3.8
95	206.0	0.0	7.5
96	215.0	2.0 L	5.7
97	216.0	3.0 R	3.9
	. . .	. . .	4.4
98	216.5	3.5 R	8.6
	. . .	. . .	7.7
99	217.5	2.0 L	6.5
100	221.0	1.5 R	3.8
	. . .	. . .	5.0
101	221.0	1.5 R	6.6
102	225.5	3.0 R	1.5
	. . .	. . .	7.7
103	225.5	3.0 R	5.8
104	230.0	0.0	6.0
	. . .	. . .	7.2
105	230.0	1.5 L	4.0
106	237.0	3.0 R	8.3
	. . .	. . .	5.9
107	241.0	3.0 R	5.2
	. . .	. . .	6.3
108	242.0	0.0	3.6
	. . .	. . .	4.3
	. . .	. . .	2.6
109	242.0	0.0	3.8
110	242.0	0.0	3.8
	. . .	. . .	1.5
111	243.0	4.0 R	7.3
112	253.0	4.0 L	5.0
113	253.5	4.0 L	7.8
114	266.5	3.0 R	12.5
	. . .	. . .	4.4
115	276.5	2.0 R	2.8
116	276.5	2.0 R	2.3
117	276.5	2.0 R	4.8
118	278.0	2.0 R	3.1
119	279.0	3.0 R	5.9

APPENDIX XVI - Continued

Tree Number	Transect Distance*	Lateral Distance**	Diameter Breast-High***
120	279.0	3.0 R	5.6
	. . .	. . .	4.9
	. . .	. . .	2.4
	. . .	. . .	7.0
	. . .	. . .	6.0
	. . .	. . .	5.5
121	292.0	3.0 R	3.8
122	295.0	3.5 R	10.5
	. . .	. . .	2.0
	. . .	. . .	1.8
123	298.0	1.0 L	9.1
124	303.0	1.0 L	6.3
125	303.0	1.0 L	12.4
126	303.0	1.0 L	5.1

*=meters from base, **=meters from transect, ***=inches.

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