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AGE STRUCTURE OF TREES IN THORN CREEK WOODS

Jon Mendelson

Size distributions, especially if coupled with age data, can be useful both in understanding inherent demographic patterns in trees and in unraveling recent forest history, for example, the timing and intensity of past disturbance. With these aims in mind, diameter distributions and age relationships are presented for populations of tree species from Thorn Creek Woods, Will County Illinois. Included are *Quercus alba*, *Quercus bicolor*, *Quercus rubra* and *Quercus velutina*, as well as *Acer saccharum*, *Carya ovata*, *Fraxinus americana*, and *Ostrya virginiana* among others.

Interpretations of observed distributions are most often made in relation to theoretical frequency distributions assumed to represent survivorship in a cohort of trees. Good fit to the curve implies a stable, all-aged population (Leak 1975). The negative power distribution is generally considered the most realistic of these models (Hett 1971; Johnson and Bell, 1975).

One commonly encountered deviation is the variously named "gap and bulge" (Lorimer and Krug, 1983) or "plateau" pattern (Ross, et al. 1982). This pattern has most frequently been interpreted in historical terms (Schmeltz and Lindsey 1965; Johnson and Bell 1975). The bulge, typically for canopy trees, represents a surge of reproduction/release as a result of a past disturbance. The gap is indicative of subsequent recruitment failure, followed by renewed reproductive success. Alternative interpretations focus on tree life history characteristics, particularly differences in mortality rates between subcanopy and canopy assemblages (Goff and West 1975), or on the inherent cyclicity of some forest types (Jones 1945). Given the recent imposition of disturbance regimes on natural patterns in midwestern woodlands, it may be impossible to disentangle their relative contributions (Harcombe 1987). Nonetheless, in light of the recent enthusiasmfor restoring these woodlands, any information on age and size structure of existing tree populations will be of some practical value.

STUDY AREA

The Preserve is the southern terminus of a broad belt of woodland lying along Thorn Creek in eastern Will and Cook counties. It is assigned to the Northeastern Morainal Natural Division of Illinois. The topography of the Preserve consists of 1) a well-dissected moraine portion, with narrow ridge tops and deep ravines, 2) a portion on ground moraine characterized by broad uplands and shallow depressions and 3) the valley of Thorn Creek itself. *Quercus alba* is the canopy dominant of uplands and ridge tops. *Quercus velutina* and particularly *Quercus rubra* become increasingly important on slopes. On steeper slopes *Q. rubra* is joined by *Acer saccharum*, *Fraxinus americana* and *Prunus serotina*. *Quercus bicolor* is characteristic of wet depressions, while *Ostrya virginiana* is locally abundant in a variety of habitats. *Ulmus rubra* and *Tilia americana* are found principally on the Thorn Creek floodplain.

Euroamerican settlement of the Preserve area began in 1834. By 1873 the land-use pattern which would last well into the 20th century was fully in place. The forest interior was divided into small (10-20 acre) woodlots, while larger farms, with attendant grazing animals, occupied the woodland perimeter. This pattern began to break down in the mid-1920s as woodlots were coalesced into larger parcels for non-timber purposes, and farming declined in the area. Preservation was largely accomplished by the mid-1070s

METHODS

Data on tree diameters, from 512 0.01 ha (10 m x 10 m) quadrats sampled during 1975-83, consisted of 1) diameters to the nearest cm for trees > 10 cm DBH, 2) complete enumeration of trees < or = 10 cm DBH but greater than 1 m in height, and 3) enumeration of plants < 1 m in nested 2 m x 2 m quadrats. Diameter distributions were constructed for 11 species using 10 cm size classes. After log transformation, best fit to the negative power curve was determined by linear regression and evaluated by correlation analysis.

Age data were obtained from cores taken in 1975 and 1982 with 43 cm increment borer. Cored trees were chosen to insure as broad a representation of diameters as possible. The 1975 diameters were adjusted to projected 1983 values using a correction factor. In all, 179 cores from 10 species were examined. Linear regression and correlation analysis were used to assess age-size relationships.

RESULTS

Observed diameter distributions of all species fit the negative power model very well; r^2 values ranged from 0.66 to 0.88. In spite of this apparent congruence, 7 of 11 species showed the "gap-bulge" pattern. It appeared most strongly in all species of *Quercus* and in *Acer*. *Carya* and *Fraxinus* showed a less pronounced form of this pattern. It was absent in *Ostrya*, *Prunus*, *Tilia* and *Ulmus*. The gaps, where fewer than the expected number of individuals were present, generally fell in the 20-40 cm diameter range while the bulges encompassed the larger size classes.(Figures 1 - 8).

Size-age correlations were significant at $p < .01$ for 9 of 10 species; r^2 values for these species ranged from 0.30 to 0.95. Thus, size appears a good predictor of age for Thorn Creek trees. However, for *U. rubra*, size and age were not correlated ($r^2 = 0.18$; $p > 0.10$). (Figures 9 - 16)

Further examination of size-age scatter diagrams, however, reveals a consistency of pattern undetected by regression analysis. Most striking among *Quercus*, *Carya* and *Fraxinus* species, it consists of two distinct age clusters. The older cluster consists of individuals recruited beginning in the 1830s and continuing for 50+ years. Recruitment into the younger cluster began in the 1920s and continues today. Trees of intermediate age are uncommon in spite of efforts to sample a full range of diameters. Trees of intermediate size are, in fact, as likely to be suppressed individuals of the older cluster or fast growing individuals of the younger than of predicted intermediate age. Comparing size-age plots with diameter distributions suggest that this intermediate sized group falls closely into the gap portions of the size distributions.

DISCUSSION

The foregoing juxtaposition suggests that, in spite of good fits to the negative power curve, tree populations in Thorn Creek Woods are not all-aged but composed of two distinct cohorts. The close correspondence between the emergence of these and significant changes in land use suggest further that anthropogenic factors may have played a central role in determining the pattern. The older group, for example, emerged during early Euroamerican settlement when removal of the original canopy together with possible fire suppression most have provided conditions for successful establishment. The subsequent period of low recruitment (~1880-1925) corresponds with the span of most intense agricultural activity, a time when grazing pressure may be presumed high. Renewed recruitment began coincident with the decline of farming in the area.

Whether this recovery phase, initiated over 60 years ago and continuing to the present, will result eventually in an all-aged stand is not clear. It may well be that cycles once induced are not easily damped. If the cycle is not damped, then the observed pattern, here attributed to human activity, may only be one superimposed on much older cycles of unknown origin.

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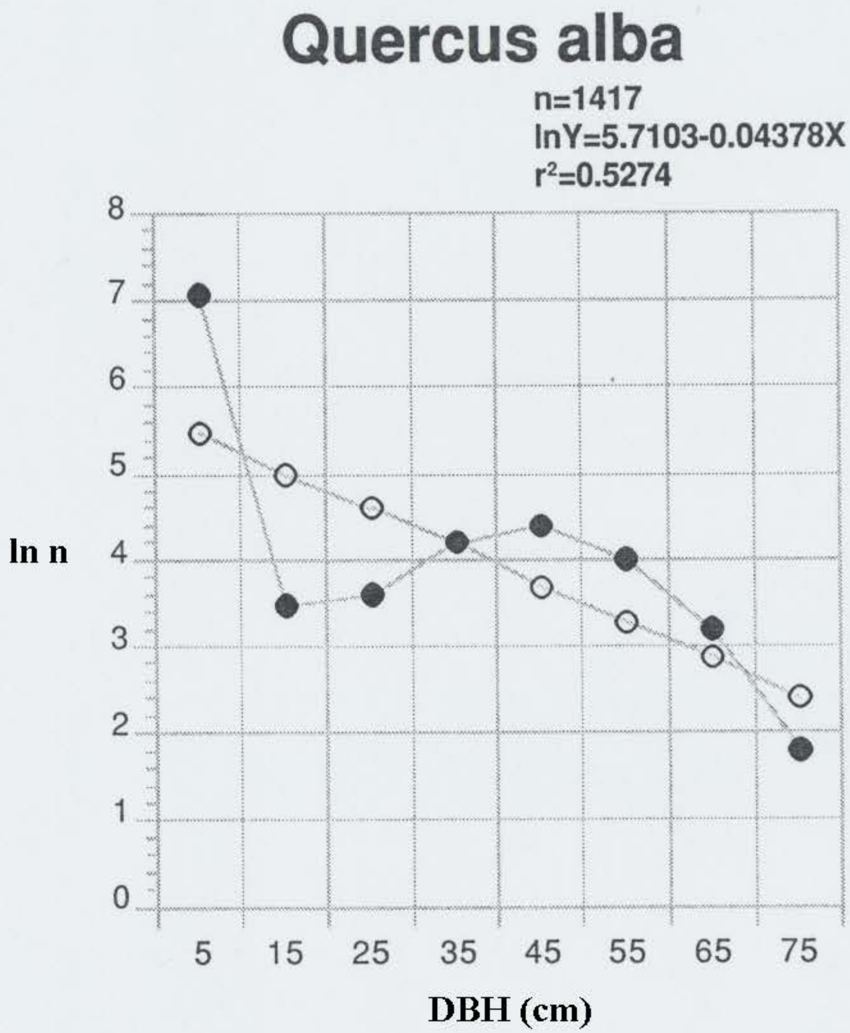
Figure 1



Quercus alba
n=1417
lnY=5.7103-0.04378X
r²=0.5274
8
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
65
75
DBH (cm)

Figure 2

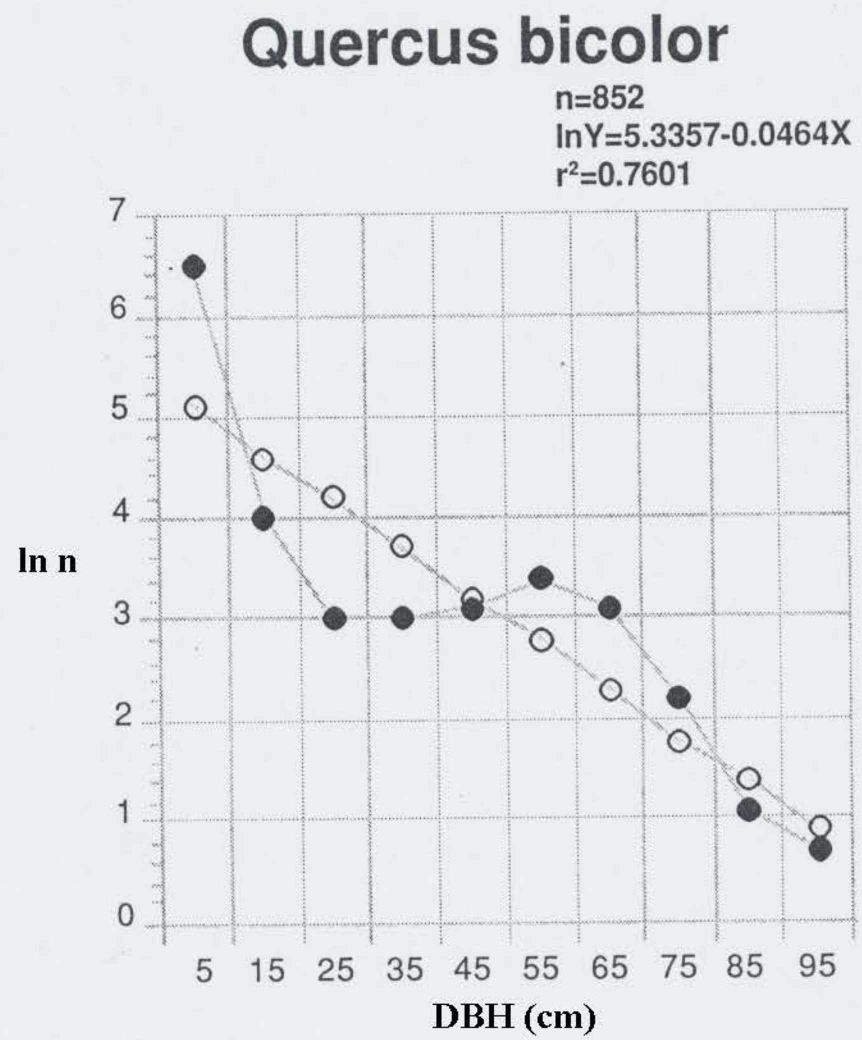

Quercus bicolor
n=852
lnY=5.3357-0.0464X
r²=0.7601
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
65
75
85
95
DBH (cm)

Figure 3

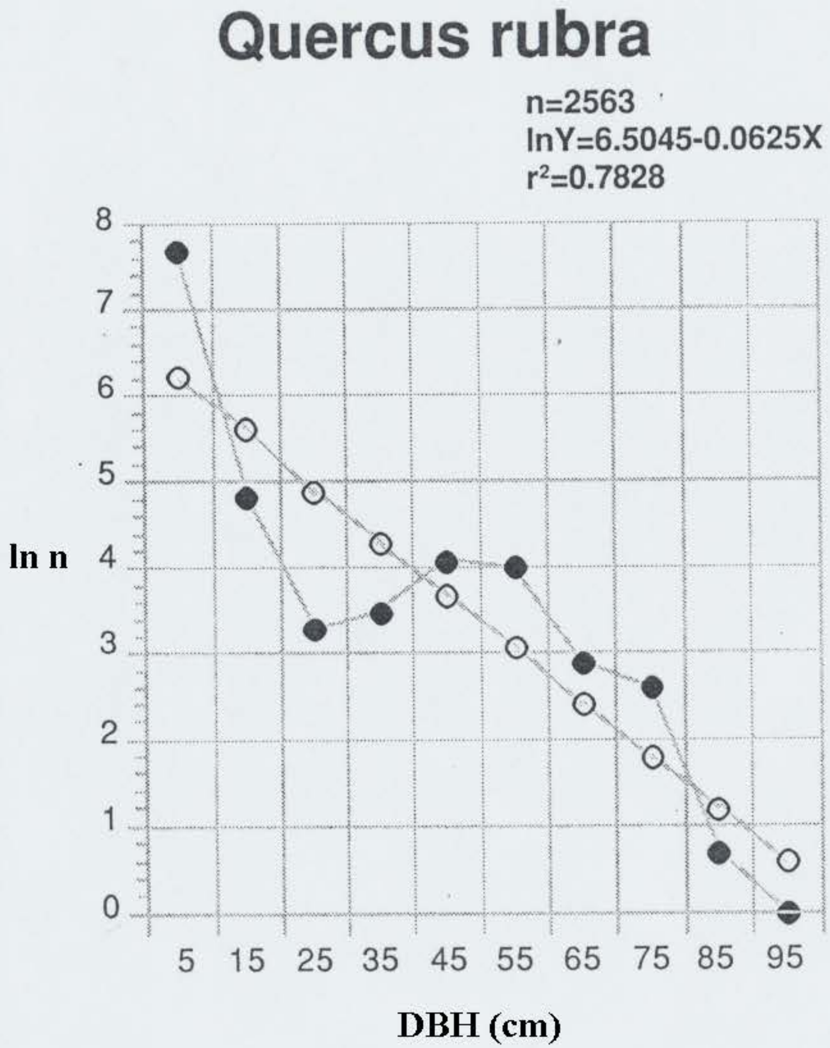

Quercus rubra
n=2563
lnY=6.5045-0.0625X
r²=0.7828
8
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
65
75
85
95
DBH (cm)

Figure 4

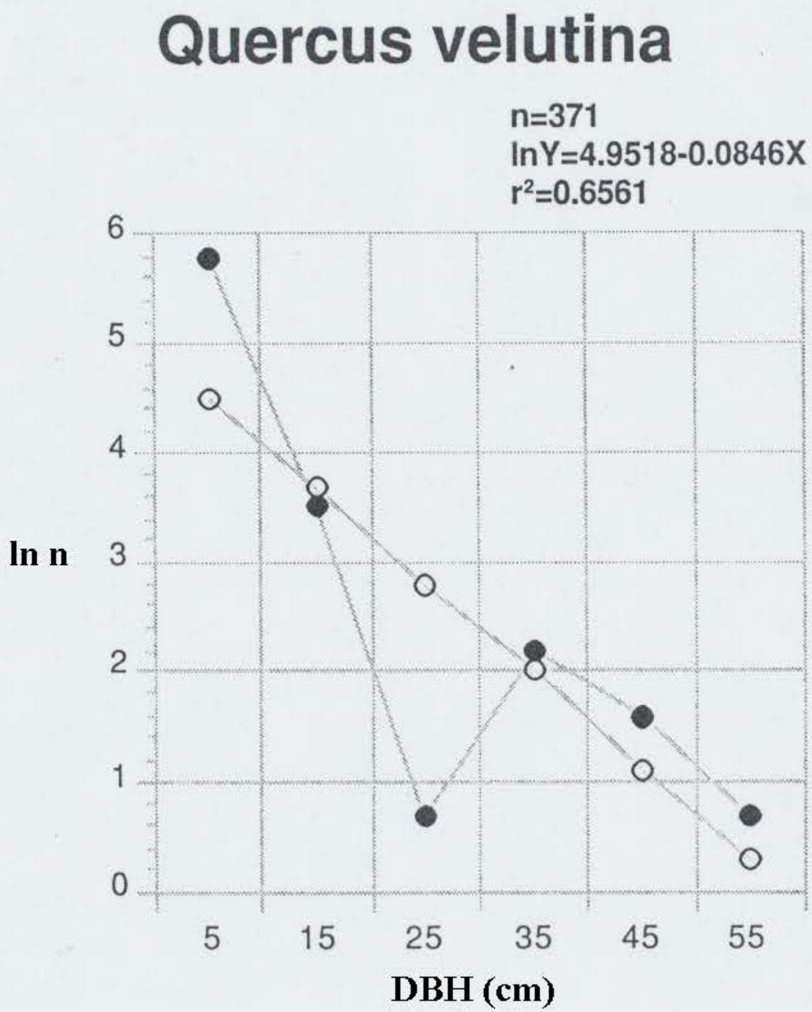
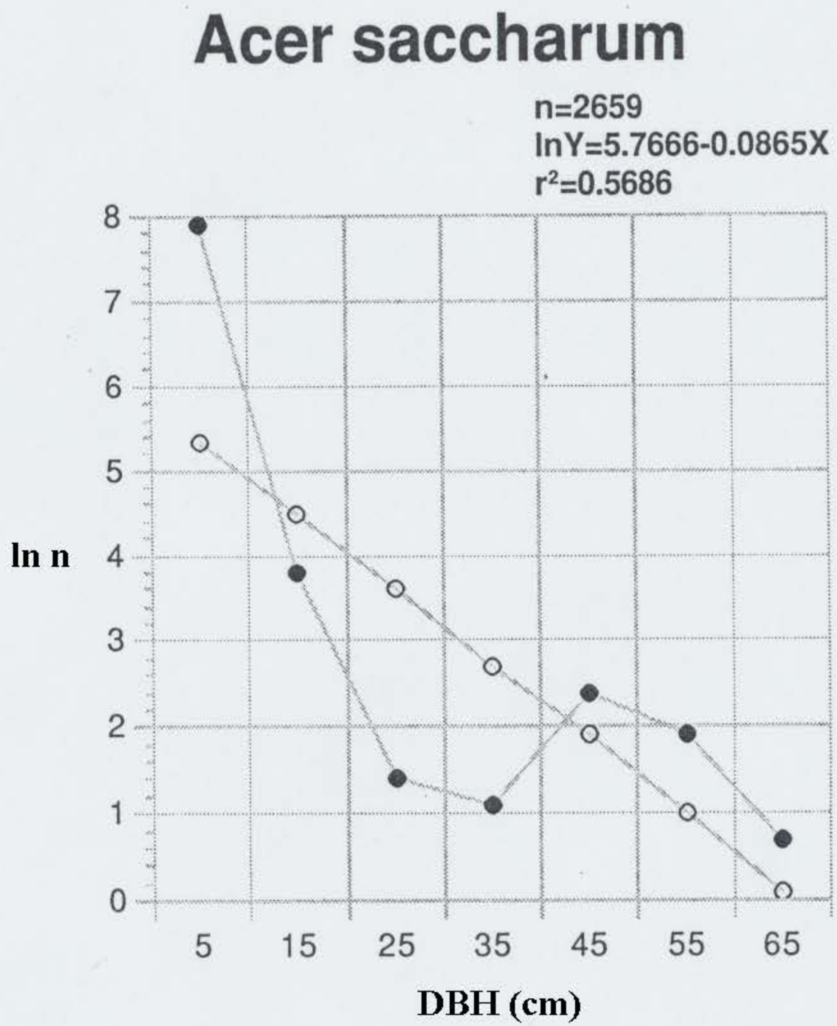

Quercus velutina
n=371
lnY=4.9518-0.0846X
r²=0.6561
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
DBH (cm)

Figure 5



Acer saccharum
n=2659
lnY=5.7666-0.0865X
r²=0.5686
8
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
65
DBH (cm)

Figure 6

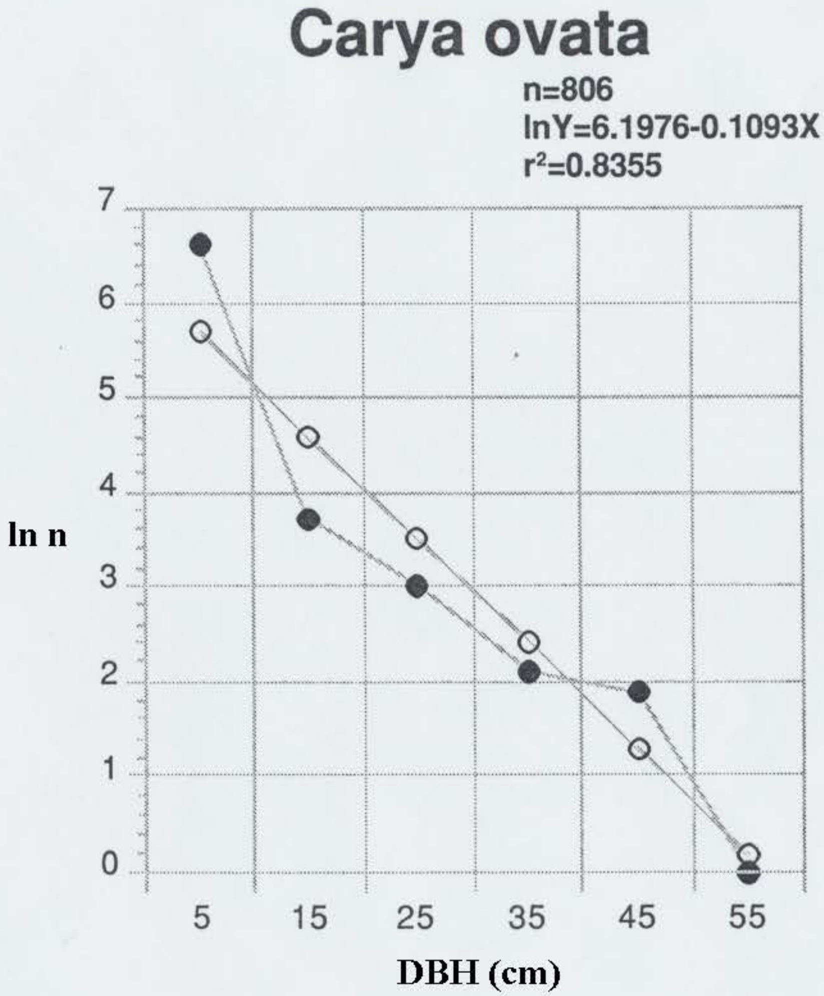

Carya ovata
n=806
lnY=6.1976-0.1093X
r²=0.8355
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
DBH (cm)

Figure 7

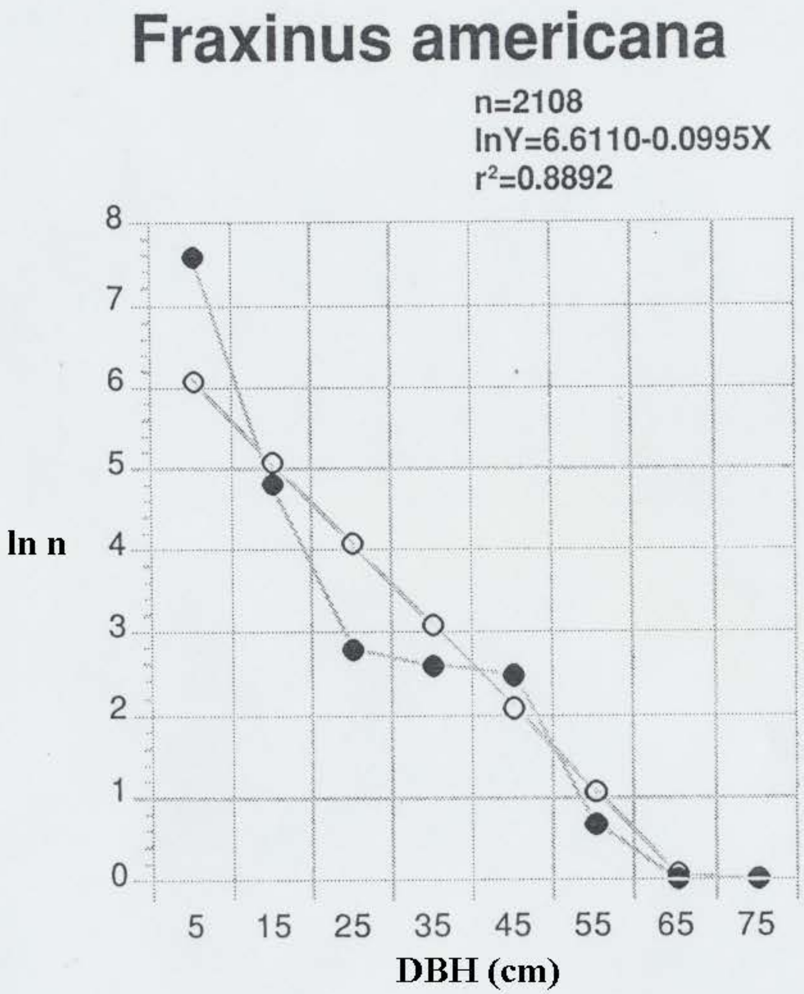

Fraxinus americana
n=2108
lnY=6.6110-0.0995X
r²=0.8892
8
7
6
5
4
3
2
1
0
ln n
5
15
25
35
45
55
65
75
DBH (cm)

Figure 8

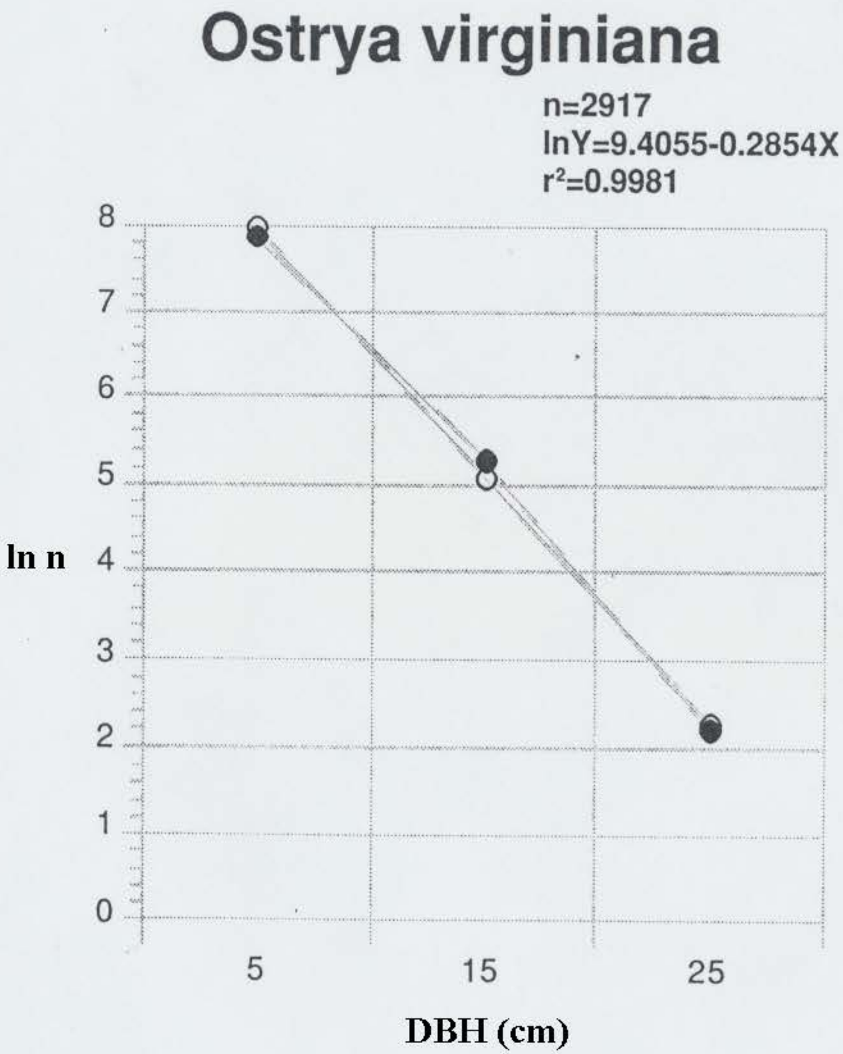

Ostrya virginiana
n=2917
lnY=9.4055-0.2854X
r²=0.9981
8
7
6
5
ln n
4
3
2
1
0
5
15
25
DBH (cm)

Figure 9

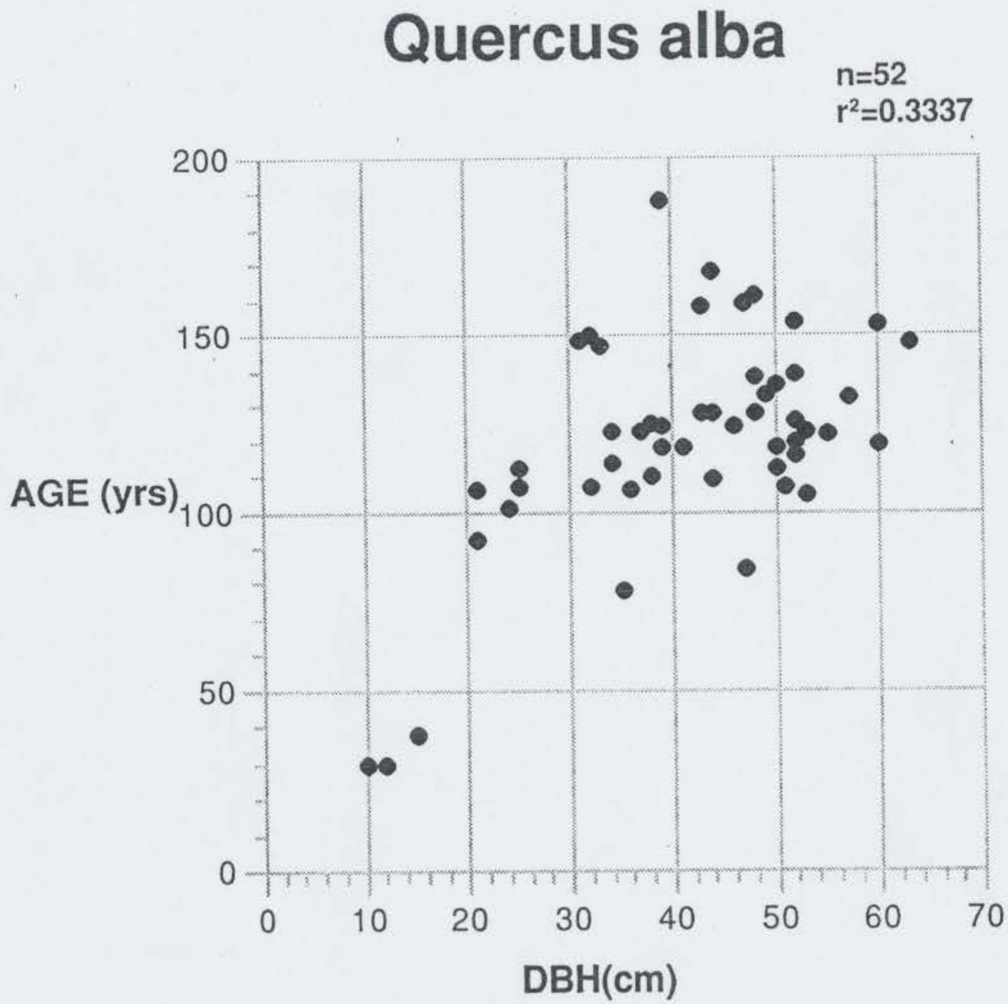

Quercus alba
n=52
r²=0.3337
200
150
AGE (yrs)
100
50
0
0
10
20
30
40
50
60
70
DBH(cm)

Figure 10

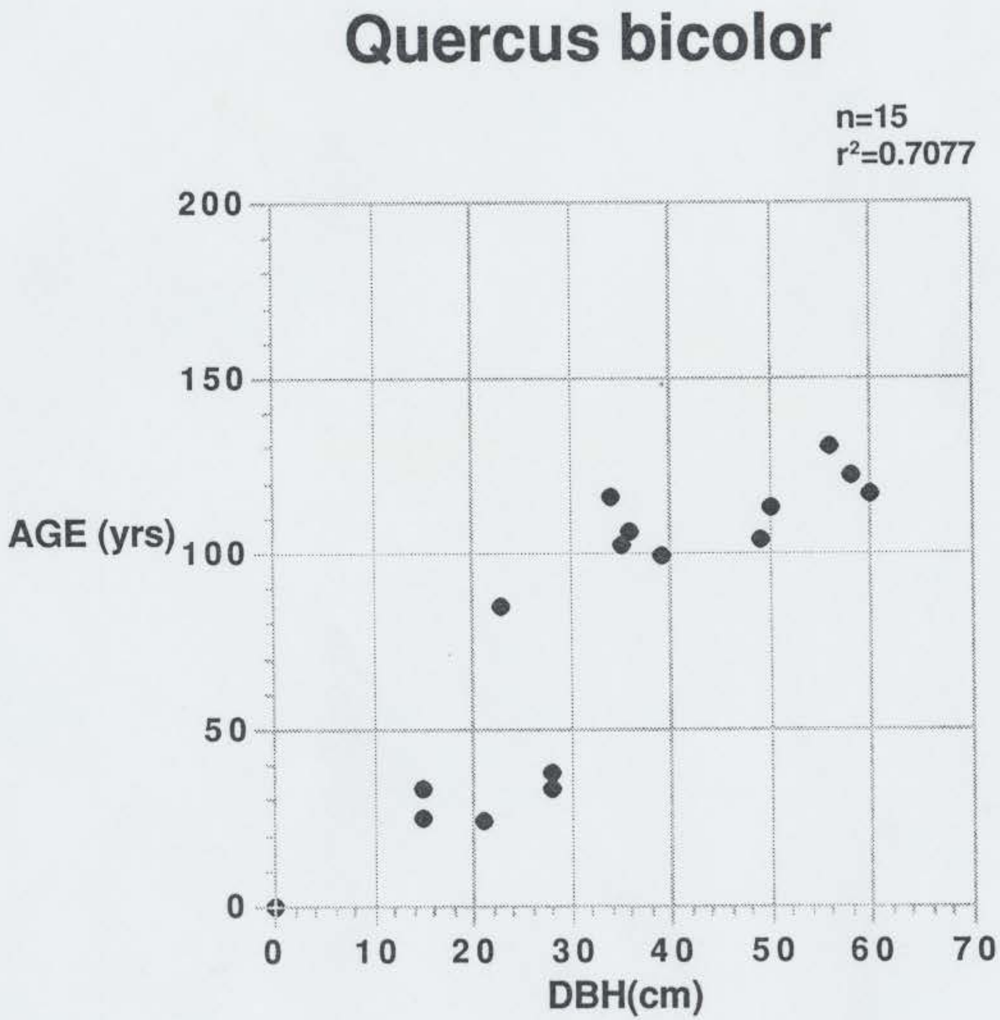

Quercus bicolor
n=15
r²=0.7077
200
150
100
50
0
AGE (yrs)
0
10
20
30
40
50
60
70
DBH(cm)

Figure 11

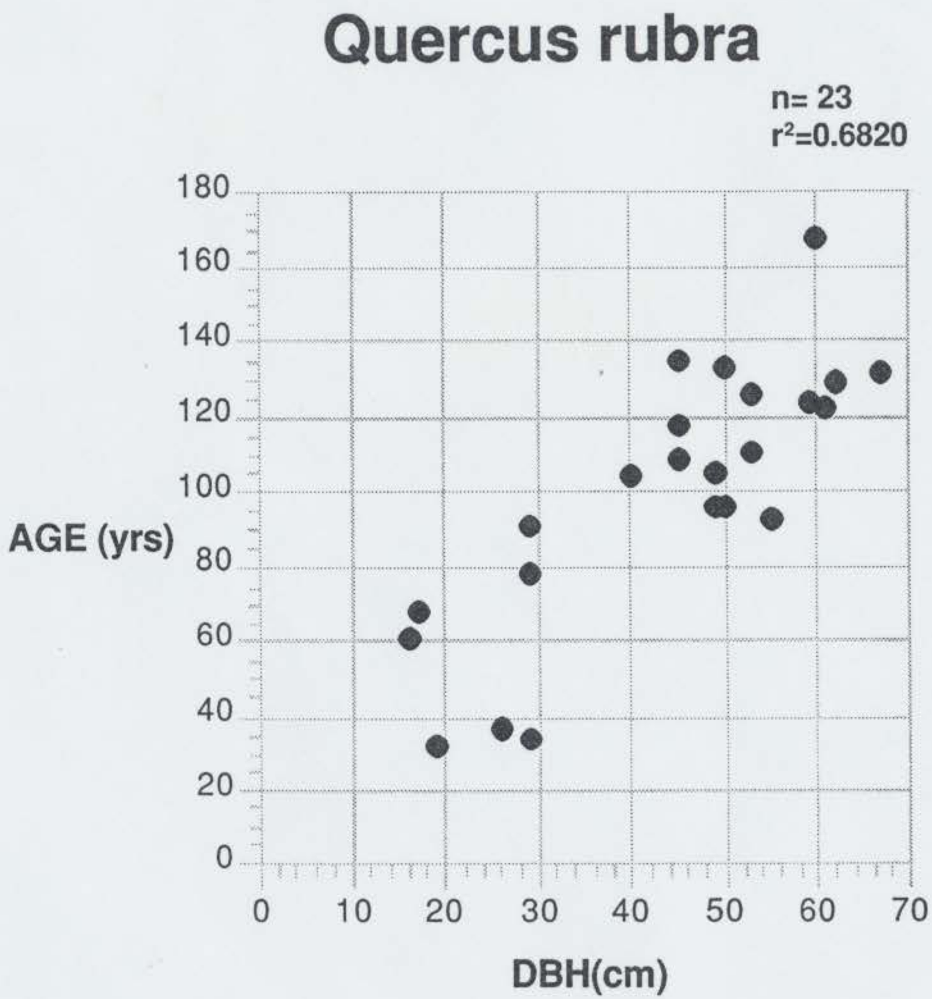

Quercus rubra
n= 23
r²=0.6820
AGE (yrs)
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
DBH(cm)

Figure 12

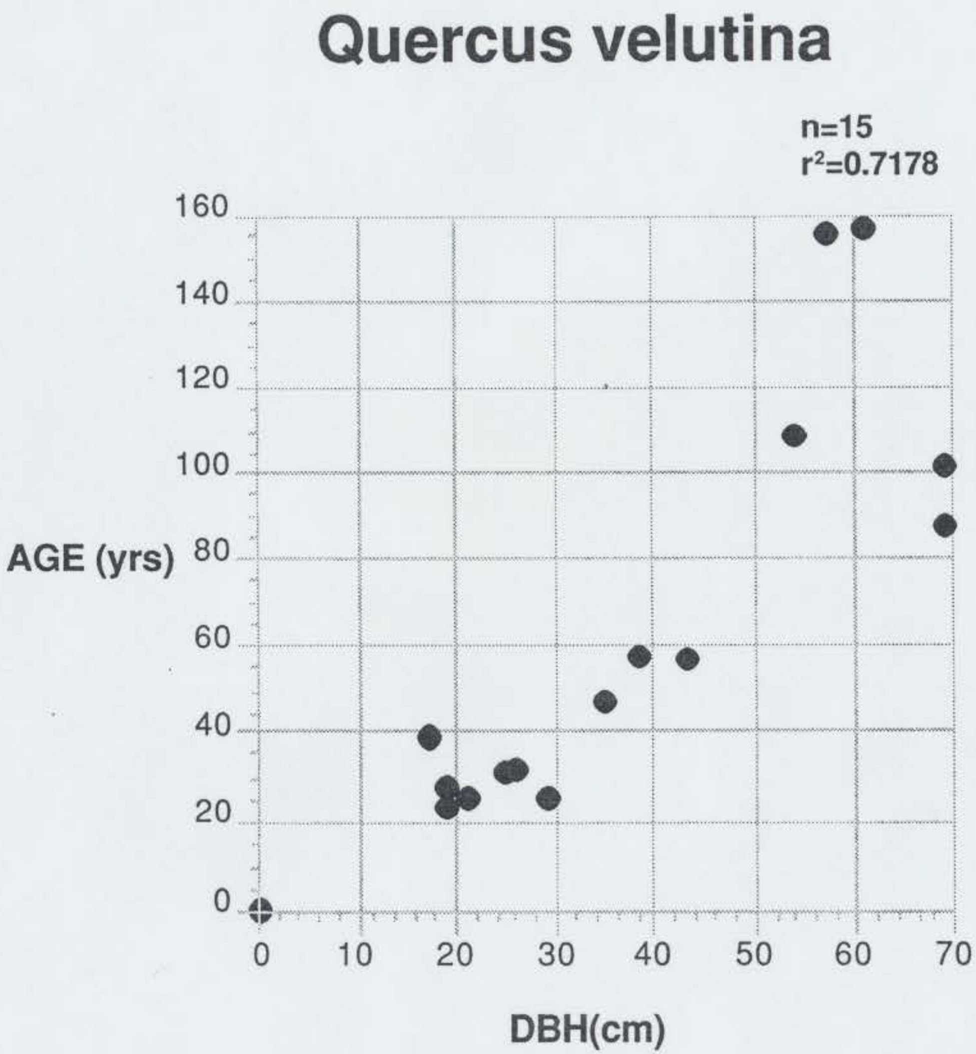
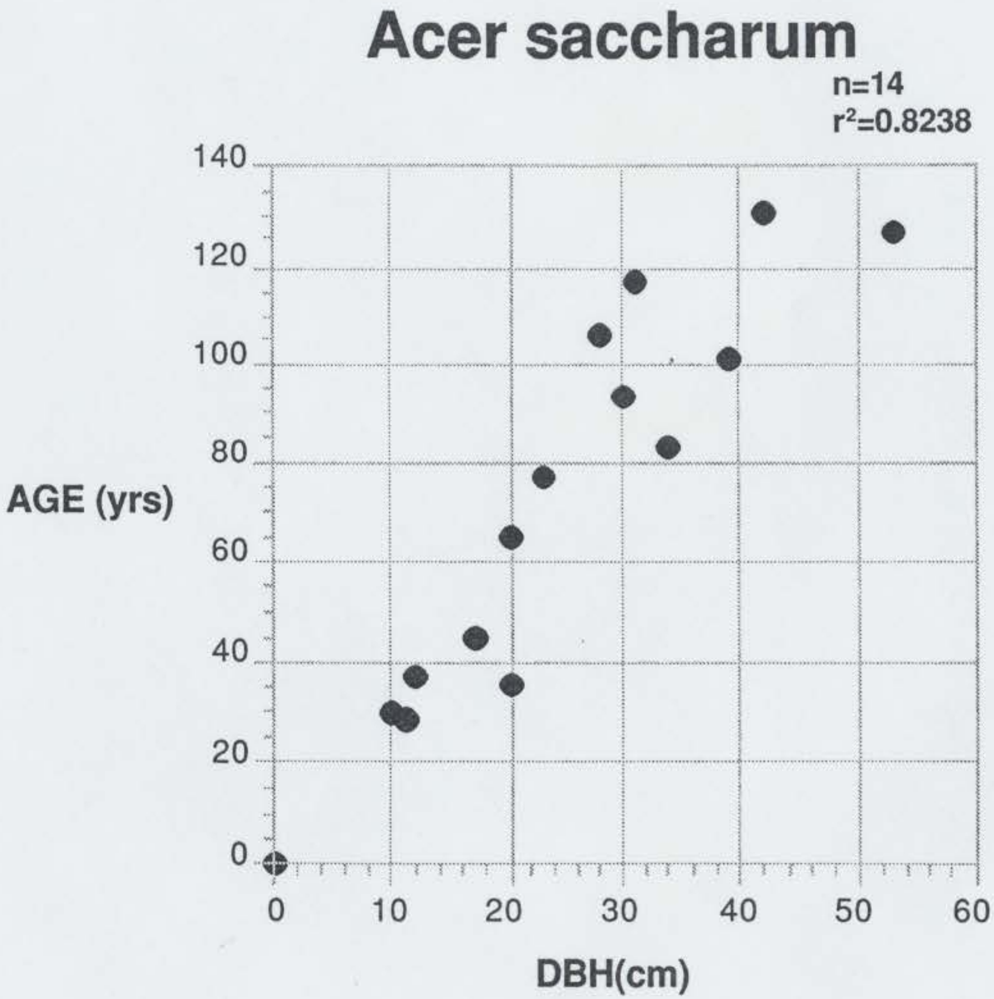

Quercus velutina
n=15
r²=0.7178
160
140
120
100
80
60
40
20
0
AGE (yrs)
0
10
20
30
40
50
60
70
DBH(cm)

Figure 13



Acer saccharum
n=14
r²=0.8238
AGE (yrs)
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
DBH(cm)

Figure 14

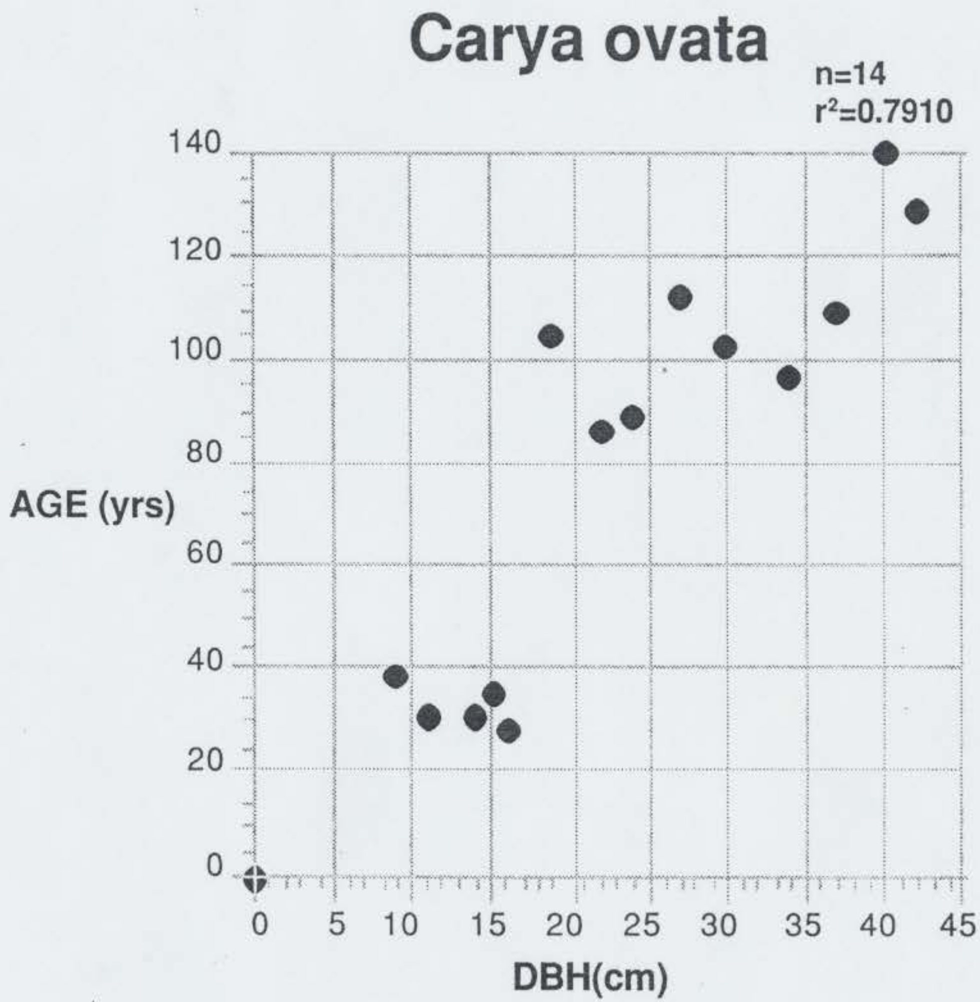

Carya ovata
n=14
r²=0.7910
140
120
100
80
AGE (yrs)
60
40
20
0
0 5 10 15 20 25 30 35 40 45
DBH(cm)

Figure 15

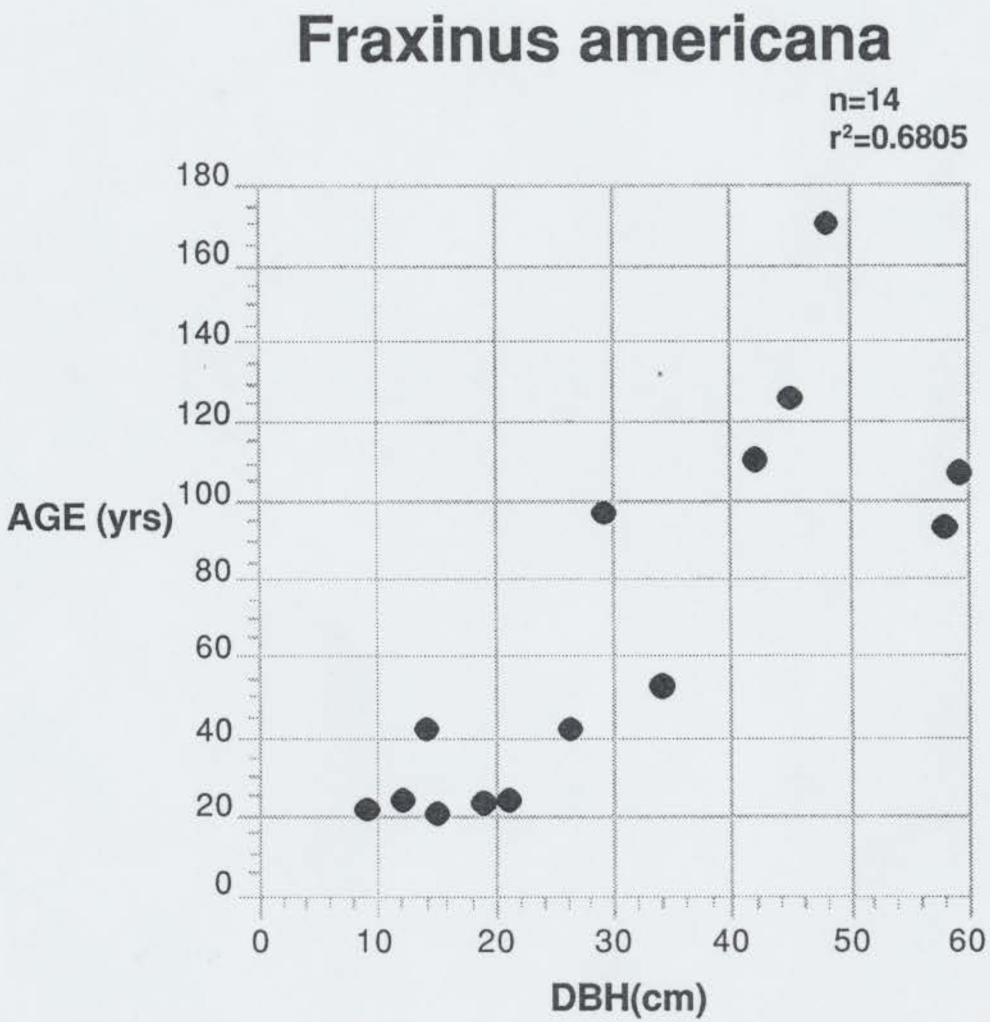
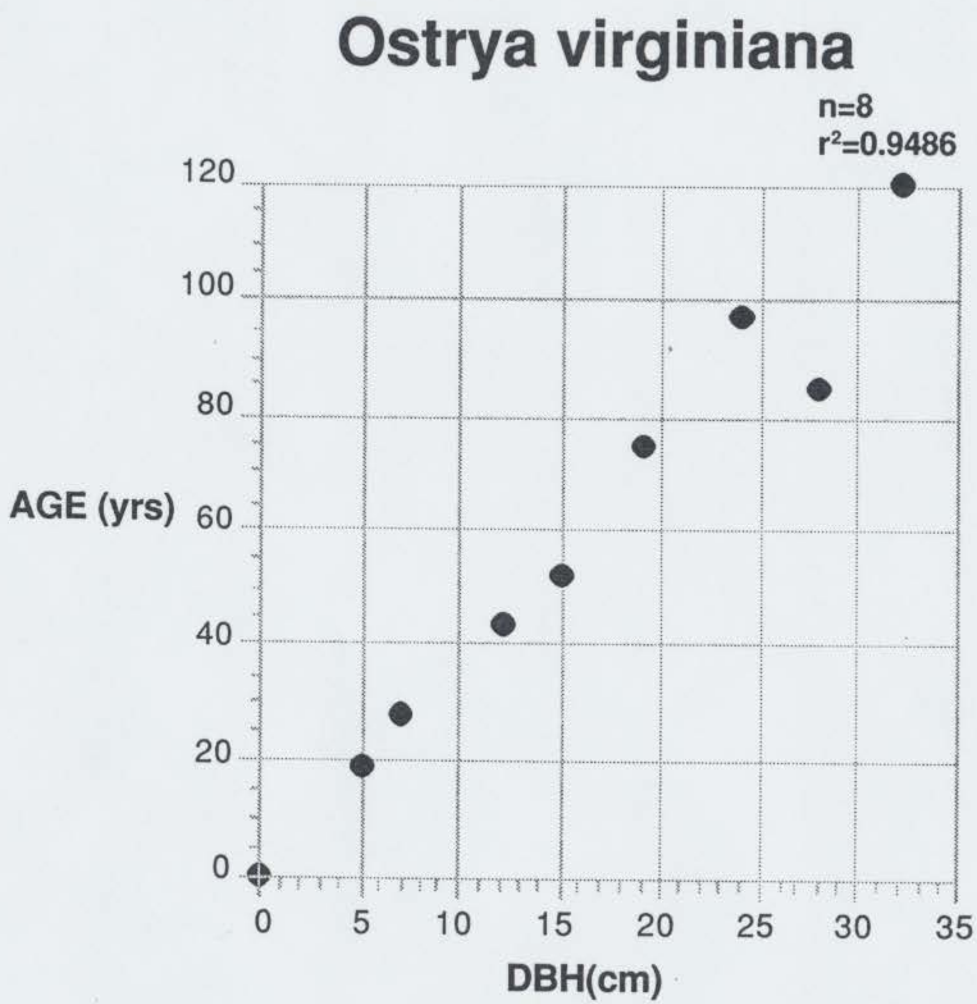

Fraxinus americana
n=14
r²=0.6805
AGE (yrs)
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
DBH(cm)

Figure 16


Ostrya virginiana
n=8
r²=0.9486
AGE (yrs)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
DBH(cm)