

Appendix 4

Erosion Photographs



Figure 1
Example of erosion alongside railroad bed



Figure 2
Poor soil quality and erosion alongside railroad bed



Figure 3
Ineffective retention wall alongside railroad bed



Figure 4
Ineffective retention wall alongside railroad bed



Figure 5
Example of erosion alongside railroad bed



Figure 6
Ineffective retention wall alongside railroad bed



Figure 7
Example of poor soil quality and erosion alongside railroad bed



Figure 8
Example of general soil erosion around grave pit

Appendix 5

Coefficient of Fragmentation

**Measuring Edge Effects, Habitat Fragmentation, Contagion
and
The Raw Probability of Patch Colonization**

John J. Sabuco

From the first papers on island biogeography by MacArthur (1963, 1967), the physical measures of patch size and distance between patches, habitat or oceanic islands, or mainland and island, have been identified as critical to the study of colonization/invasion, species diversity, and the continued viability of populations (Wilcox 1980, 1985). In subsequent years, habitat fragmentation has been found to cause barriers to species movement or migration (Meffe and Carroll 1997), crowding effects (Leck 1979, Noss 1981, Lovejoy *et al.* 1986), local and regional extirpations, (Wheelright 1983, Lawrence 1990, Shaffer 1991, Carlson and Aulen 1992, Powell and Bjork 1995, Ferreira and Laurance 1997, Fisher and Stocklin 1997). Reduction in core area causes a variety of detrimental edge effects (Janzen 1983, 1986, Ranney *et al.* 1981, Murcia 1995, Harris 1984, Franklin and Forman 1987, Chen and Franklin 1990, Chen *et al.* 1992, Paton 1994). Therefore, tracking human encroachment on habitat and fragmentation over time is critical to understanding the functioning of ecosystems (Saunders, Hobbs and Margules 1991). In addition, it is important to be certain that restoration plans are not designed to emulate fragmented habitats. Future acquisitions or additions to preserves must also be analyzed with an appropriate quantifiable method for the evaluation of the aforementioned effects.

Krummel (*et al* 1987) developed an index of fragmentation which uses a fractal dimension in its calculation. This fractal dimension was estimated by calculating the slope of the regression of log Perimeter on log Area for a series of patches ranked according to size. Krummel (*et al* 1987) then scales the value of the slope to a value of 1 to 2 to emulate the fractal dimension of a disc where 1 equals a perfectly circular perimeter and values nearing 2 indicate a very convoluted perimeter. Milne (1991) correctly points out that perhaps, the biology that determines the usefulness of the application of Krummel's index has not been fully established though in some cases it is undeniably useful. Milne's (1991) conclusion is based on the response of fractal perimeters to landscape constraints.

Krummel's index returns a value indicating less convolution for some scales of the perimeter as the actual perimeter of a patch approaches artificial landscape constraints because the index does not account for the simultaneous change in the area of the patch. This has the effect of claiming that core area increases for that patch when in fact the core area remains constant or decreases. Krummel's index also demonstrates that the fractal dimension for natural forests does not increase linearly with patch size, but rather, it peaks at different scales of analysis (Mladenoff 1997). The response of macro-organism diversity however, is exponential with relation to patch size (Wilcox 1985, Lovejoy et al. 1986), patch dispersion (Nekola and White 1999) and edge degradation (Murcia 1995, Franklin and Forman 1987, Chen and Franklin 1990, Chen *et al.* 1992, Maurer and Heywood 1993, Kattan, Alvarez-Lopez and Giraldo 1994 and Nekola and White 1999). An index of fragmentation or patch dispersion should react in precisely the same manner regardless of scale, and the thoughtful scientist should be certain that the scale chosen for analysis is appropriate to the question (Lord and Norton 1990).

I have developed an index of core area that avoids this pitfall being applicable to all scales of analysis. The index can be used to make predictions with regard to resident species in a preserve, to address future land acquisition, or to compare similar preserves (or potential preserves).

Following Krummel's (*et al* 1987) premise, the smallest perimeter possible for any given enclosed area is a perfect circle (Milne 1991). Therefore, the perimeter of a subject site can be compared to the perimeter of a disc having the same area as the subject site (Milne 1991, Krummel *et al* 1987). In this way, we may judge the degree of convolution of a site's perimeter or its proportional core area. I propose the following ratio as an index of core area based on this logic.

$$K = \frac{\text{the perimeter of the subject area if that area were disc-shaped}}{\text{actual perimeter of the subject area}} =$$

$$K = P_D / P =$$

$$K = \frac{\pi \cdot 2 \cdot [\sqrt{(A/\pi)}]}{P}$$

Where: A = the area of the sample

P = the perimeter of the sample

P_D = Perimeter of area of same size as sample if shaped as a disk

If our sample site were a disc, we could divide its area by π to obtain the radius squared. Two times the square root of the radius squared is the diameter. π times the diameter is equal to the circumference of a circle that represents the idealized, smallest, perimeter of the sample site. Therefore, the clause $\pi \sqrt{4A/\pi}$ represents the perimeter of the sample area if that area were disc shaped. When divided by the sample area perimeter, it creates a ratio representing departure from the idealized, smallest perimeter. The range of the index is a ratio between 0-1. When K is equal to 1, the area is enclosed by a circular perimeter. As K becomes smaller the sample area is enclosed by a perimeter further removed from a circle gaining greater complexity (convolution) and reducing core area (Milne 1991, Schneider 1994). K in fact, is a direct estimate of the fractal dimension of a site's perimeter / area relationship. It has the same range as the fractal dimension where 1 equals the lowest level of convolution – a disc – and 2 equals the greatest level of convolution possible within a plane. It can be interpreted in exactly the same manner as a fractal dimension and can be converted to the estimated fractal dimension d with the equation:

$$d = (1-K) + 1.$$

When the core area of a site is degraded to the point where patches of the original community are now separated by a matrix which is unsuitable for most or all of the species in the community we say that the habitat has been fragmented. K can be used with sample sites composed of several disjunct parcels (Figure 1) however it was intended that this particular index would be unaffected by the distance between parcels. K values are determined only by the area enclosed within a subject site perimeter or within the perimeters of several patches. The distance between patches might vary considerably, yet have the same core area within their collective perimeters.

There are several qualities which are important in evaluating fragmentation. The rate of a species' (or its propagule's) movement in one general direction among patches (or in a continuous habitat) is called percolation (Murcia 1995). The resistance to that movement caused

by spatial characteristics in the landscape is called permeability (Murcia 1995).

A species' ability to move from its place of origin to a receptor or target site decreases negative exponentially with distance (Roughgarden, Gaines and Pacala 1987, Brothers and Spingarn 1992) and is known as its diffusion rate or its dispersion ability.

Contagion refers to genetic communication between patches (not to be confused with the statistical term). It is measured using the relationship of patches or islands to each other in terms of size and distance. A series of measurement techniques is required to quantify these characteristics. For the purposes of modeling, it is important to use practical and related measures that can be applied to a wide variety of organisms on many scales.

There are two indices in the literature that attempt to measure the dispersion among patches. One is called the Proximity Index and was developed by Gustafson and Parker (1992). The Proximity Index uses a nearest neighbor method of calculating the contagion of patches in a user-defined area. The index is the sum of the area of each patch after being divided by its nearest neighbor distance. While the inclusion of patch area is sound, the idea that a measure of distance is adequate to the task of calculating dispersion of patches is contrary to the prevalent thought on this subject which is that a species' ability to disperse over any given distance (Okubo and Levin 1989), and patch/island similarity (Nekola and White 1999) both have a negative exponential relationship to increasing distance between patches or islands. Had Gustafson and Parker (1992) used a mean square measurement between islands they would have been closer to a viable index (Milne 1991).

The second index of dispersion in the literature -- the Isolation Index -- was created by Nekola (1999). Nekola (1999) uses an exponential relationship between patches to down-weight the genetic effect of a patch on other subject patches based on its increasing distance from those patches. This approach is based on sound ecological principles (Okubo and Levin 1989, Nekola and White 1999), however the method leaves the rate of exponential decay to the user's discretion. He makes no argument for any particular rate of decay, propounding instead the idea that every biological function or species dispersion characteristic has a particular decay rate associated with it, and it is up to the user to make that determination.

I believe that one can begin with the notion that dispersion among patches or islands is the starting point for the evaluation of all other calculations regarding biotic factors affecting the movement or migration of species or their propagules in a fragmented landscape. Nekola (1999) demonstrates that change along environmental gradients as patches become more distant from each other, leads to the differential competitive sorting among species. This sorting is affected by the environmental amplitude – or niche breadth – of the species, and the dispersal ability of species. All of these important factors are ultimately defined by the distance between patches, and calculations regarding the distance between patches necessitate accounting for the size of the patches.

To calculate the raw probability that a patch or island is invaded by a species from another site – based strictly on habitat size and isolation – we need only divide the area of the target patch in question (A_t) by the area of a disc which has a radius (R_i) equal to the greatest possible distance between perimeter points from the invading patch (or population if there is a difference in size) to the target patch (Figure 3). The equation is:

$$P_1 (\text{patch } t \text{ is invaded from patch } i) = A_t / \pi R_i^2$$

The relationship of target size and distance from the source is treated exponentially with this formula (Figure 4). By extension, the probability that a particular target site is invaded from any set of sources is constituted of the previous equation summed across all patches that harbor potential invaders.

$$P_2 (\text{patch } t \text{ is invaded from among all patches}) = \sum_{i=1}^n (A_t / \pi R_i^2)$$

Clearly, we can evaluate the contagion among all patches by yet another extension of the equation where the probability that a target patch is invaded is summed across all potential target patches.

$$D = \sum_{\substack{i=1 \\ t=1}}^n (A_t / \pi R_i^2)$$

The value D , measures the likelihood that gene flow will occur among all patches. This index reacts exponentially to average inter-patch distance and to patch size. Contagion and its subordinate probabilities are strictly a function of a mathematical system and as such they assume that the recolonization effort is ongoing, that colonists can travel the required distance, that the geographical direction that colonists may travel is random, the matrix is benign, and that at least one propagule can survive at each target site. It can be modified by life history traits of species in the patches, climate traits or any other factor the user requires to define a more exact value.

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Appendix 6

Ohlendorf vs. IDOT

A Tree Valuation

Performed using Volumetric and Maturation Comparison Methods

For Trees Located on a Property Commonly Known As:

The Southeast Corner of Klemme and Exchange Roads

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Site Map – Aerial Photograph

Table 1

Figure 1

Figure 2

Figure 3

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A TREE VALUATION

GENERAL INFORMATION

Eldertree S&B Client (User): Melvin Ohlendorf

Client Contact: Melvin Ohlendorf

Client's Address: 3041 East Offner Road
Beecher, Illinois 60423

Client's Customer: Illinois Department of Transportation

Subject Site Name or Description: Vacant forested land

Subject Site Address: Southeast Corner of Klemme & Exchange
Roads

Date: January 12, 2004

Date of Inspection: November 3, 2004

Field Inspector(s) Consuelo Cazares
John Sabuco
Paul Vicari
William Sluis

File Number: E04-179L

Executive Summary

PURPOSE AND SCOPE OF WORK

It is our purpose to determine the present-day dollar value of 3 white oaks (*Quercus alba*) and 7 bur oaks (*Q. macrocarpa*) on the subject property. The trees to be valued lay between the east edge of Klemme Road and a line determined by the Illinois Department of Transportation (IDOT) that is roughly 20-30 feet east of the roadway. Eldertree used a line 10 feet east of a line of stakes placed by IDOT to determine the position of this eastern boundary. The trees included all trees with a diameter at breast height (DBH – 4 feet above base of tree) of 10 inches or greater per state rule.

OVERVIEW OF METHODS

We used two methods to arrive at a fair price for the trees that are to be removed. There is a third method that I will describe that is outside of the expertise of this company. The first method used is to approximate the biomass (the approximated total volume of above-ground biological material) of the trees to be removed in a scientifically-accepted manner, convert the difference to a value factor or multiplier and then compare that biomass to the biomass of commercially available trees. This then allows for the same factor to be used to calculate the price of the trees to be removed based on biomass.

Our second approach uses age as mediator to determine the comparability of the trees to be removed and commercially available nursery stock. Nurseries know precisely how long it takes to bring a tree of a given species to a salable product from initial propagation. Therefore, we determined the age of the trees to be removed and used this to determine a multiplier that could be used to arrive at a dollar value based on the price and age of comparable nursery stock.

The third approach that is commonly used is a real estate valuation method. In this method, the value of the land is determined with and without the trees removed. The highest and best use of the land must be determined first. For instance the property in question probably has a highest and best use as estate housing. A qualified appraiser would determine the value of each lot as wooded with ancient trees or as lots without the large trees. The difference in lot price is the value of the trees. We are not qualified to use this method, however, we have often had the opportunity to associate this method with our own results during the 26 years this company has been in business and have found *concurrence in all cases*.

RESULTS

We have determined the value of all ten trees as follows.

Method	Value
Volumetric comparison	\$1,671,250
Maturation comparison	\$175,000
Average	\$923,125

Methods

All measures, though originally taken in metric values, have been converted to English system values so that the reader might follow this report more easily.

METHOD 1 – VOLUMETRIC COMPARISON

Determination of Height

ESB used a Clino Master Clinometer to determine the height of trees. Using a baseline of 100 feet, the base of a tree was sighted and the percentage noted. Then the top of the tree was sighted and the percentage noted. These percentages are then added together and multiplied by the baseline to determine the height of the tree.

Determination of Basal Area

Basal area is the area of a cross section of the trunk of a tree at a specified distance above ground. It is an accepted measure of biomass in forest ecology (Mueller-Dombois and Ellenberg, 1974, Grieg-Smith, 1983, Curtis 1959)

We obtained the circumference of the tree trunks at breast height less the thickness of the bark and divided the value by pi to obtain the diameter and again by 2 to arrive at the radius. This number was squared and multiplied by pi to arrive at the basal area.

Determination of the Coefficient of volume

Basal area is accepted as a measure of mass used by ecologists for individual trees when determining the biomass of trees in a forest because as branches divide and divide again there is no increase in mass as indicated by girth of the branches. In other words, if the branches of a tree could be compressed into a single branch or rather an extended trunk, the trunk would form a consistent cylinder of wood with a cross section area that is roughly equal to the basal area as measured above.

Basal area and height are highly correlated in nursery-grown tree stock, and these are the common indicators of nursery stock value. Prices for stock are heavily based on basal area as represented by DBH or height (as well as rarity, difficulty in propagation, and nursery time to salable stock). Basal area and height are *not* correlated in trees of advanced age (such as the subject trees) due to a variety of environmental conditions that can affect height, and girth of the trunk separately (Caswell and Cohen 1993, Curtis 1959, Mueller-Dombois and Ellenberg 1974). The correlation coefficient for the trees on site is found in Figure 1 and there is no correlation between height and basal area for the ten trees on site ($r = 0.0182$). Therefore, we must use the product of the two measures to attain a common measure of volume or aboveground biomass for all trees. The product of height and basal area is the most common method of determining the biomass of individual trees (Grieg-Smith 1983). This measure is the coefficient of volume V .

ESB also determined the coefficient of volume for 3-inch diameter, oak nursery stock based on data collected by Sabuco (1996) from over 300 specimens.

Determination of Value

The coefficient of volume for the ten trees to be demised (V_D) was divided by the average coefficient of volume for the 3-inch oak nursery stock (V_N). ESB then took the sum of these values (ΣV_D).

ESB averaged the wholesale prices for 3-inch oak nursery stock from 12 sources in the Chicago Area, and then multiplied that value by 0.95 to account for the possible bias that higher priced nurseries may have been selected accidentally. This number was rounded to \$350.

The value for the trees (**C**) was then determined by dividing the sum of values (ΣV_D) after division by the value of nursery stock (V_N) and then multiplied by the modified average wholesale value of the nursery stock (\$). The equation is:

$$C = \$(\Sigma V_D / V_N)$$

METHOD 2 – MATURATION COMPARISON

Overview

Trees in temperate climates form (nearly) annular growth rings within the xylem wood that hardens and preserves a record of the growth within the trunk. If it were possible to do so, one could simply count the rings that a tree produces from the outer edge to the center of the trunk to determine the age of the specimen. Cutting down a tree to determine its age is, perhaps, a bit harsh for the information that is retrieved. Therefore, foresters have developed a coring tool that retrieves a piece of wood from the trunk that is a few millimeters thick and 8 to 18 inches in length in which the rings can be counted. These coring tools are rarely long enough to retrieve a core sample from the center of the tree, so scientific methods must be used to estimate the age of the tree based on a 8, 10, 12 or 18-inch core sample. Generally, there are five areas in which errors can occur in making this determination, assuming the rings are counted correctly within the sample.

Error Type	Name of Error	Under/Over Estimate
The diameter must be calculated from point above the root flare which means that the growth rings that are below that point are not captured. Calculation error is usually 20 years or less	Juvenile Capture Failure	UNDER
Trees do not produce growth rings in every year. Calculation error in trees in temperate climates is 1 year missing per 50- 70 years of growth.	Missing Rings	UNDER
Core is not a true radius of trunk. Calculation error depends on degrees of incorrect angle but no usually more than 5 years per inch of core. Easily corrected.	Skewed Core	UNDER
The core sample from the outer rings of older trees usually represents the slower growth of the tree, so rings are more compressed in the sample. Calculation error may increase the age of the tree by as much as 5 to 15%.	Incomplete Sample	OVER

Error Type	Name of Error	Under/Over Estimate
Estimate of negative exponential growth function from mature trees to correct for Incomplete Sample error does not fully correct for the functional rate of declination. May account for 1 to 5 % overestimate.	Sample Bias	OVER

Incomplete sample error accounts for a greater absolute error than all other error types combined. Therefore, this is type of error is rigorously corrected. The skewed core error is easily corrected using trigonometry. Missing rings error is impossible to correct. Juvenile capture error is impossible to correct because growth of forest trees are not easily predictable in their early years. A sapling may sprout and grow to 3 or 4 feet in height and not grow significantly again for many years until there is break in the canopy, and it reaches for the gap (Sutherland 1990). Conversely, a sapling may experience no impediment at all and it will display uninterrupted growth for its entire life time. There is no way to know.

Normally, after correcting for the types of error that we can correct for (Skewed Core and Incomplete Sample), ecologists assume there is some balance among the remaining types of error (Juvenile Capture Error, Missing Rings and Sample Bias) or at least that the estimated age derived from the process is close enough to the real age to use for the model in question. Correlative field studies have borne out this assumption (Harper 1977). A discussion of these error types is always requisite, however, when working with core samples from trees.

Collecting Core Samples & Counting Annular Rings

ESB used a Suunto 12-inch core sample with a Teflon[®] coated bit to extract the cores from the ten trees to be demised. Samples were placed in plastic zipper bags with absorbent paper to control moisture. ESB labeled the bags with indelible marker to indicate tree species and position. The holes remaining in the trees from coring were filled with biologically inert, self-hardening, flexible filler. ESB also measured the circumference of the trunk of each tree at breast height and calculated the radii as described under the section titled **Determination of Basal Area**.

ESB lightly sanded the core samples with extra fine abrasive cloth and then immersed the cores in water to accentuate the differences between rings. Under 30 power magnification, the average arc of the rings was determined by overlaying a cross-hair grid and aligning the greatest extent of the arc with the centerline of the core sample. Only one sample had to be corrected for angle. Using a microscope, the average width of the rings from the entire length of the core was calculated and then divided into the radius of the trunk to correct for the Skewed Core error.

ESB counted the rings in the core sample and extrapolated the total number of rings per radius of the tree based on the rings per increment of measure to arrive at the number of years that the tree has grown after reaching breast height (uncorrected age after breast height – UAABH). This number is an over-estimate in most cases because of the incomplete sample error noted above.

Correction for Incomplete Sample Error

Trees slow in their growth as they get older (senesce). This slowing manifests as a negative exponential decline in growth rate.

Using Statistica 7.0 by Statsoft, ESB fit a negative exponential function to the data which was sorted in descending order. The fit of the function to the data appears to be accurate (Figure 2) however the first data point seems to be greater than the function anticipates. This could indicate that the best function fit is a Zipf-Mandelbrot distribution. To determine this, the Y-axis is converted to a logarithmic scale. The result shows that the physical variance from the distribution is similar to the variance of all other data from the fitted function and that fit is acceptable. The equation of the fitted negative exponential function is:

$$y = 661.2685^{(-0.0513x)}$$

of the form:

$$y = a^{(-bx)}$$

Where y = age, x = an individual tree, a = the intercept on the y axis after extension from a right-handed Riemann sum, and $-b$ is the rate of declination.

The UAABH is multiplied by the rate of declination (0.0513) and that product was then subtracted from the UAABH to arrive at the estimate age of the tree less the age at breast height. We have made the assumption that all other forms of error cancel each other, and therefore call this number the estimate age.

Determination of Value

Sabuco (1996) determined the age of nursery stock in oak trees of several species from samples of more than 300 individuals per species, grown on their own roots. The nursery stock was 2, 2.5, and 3 inches in diameter and located in nurseries in northeast Illinois and northwest Indiana. The age was determined from propagator's records. The average age for a 3-inch bur oak was 5 years 2 months and for a white oak was 5 years 8 months. By dividing the estimated age of a tree (A_E) by the average age of bur/white oak stock of 5.5 years (A_S), we arrived at a multiplier that we used to multiply the wholesale price (\$) of the 3-inch stock to arrive at a value based on the age of the trees to be demised.

$$C = \$(A_E / A_S)$$

Discussion

The methods used in this report assume that the value of a nursery-grown tree continues to increase in value as the tree gains in size and age. It may be argued, that the early years of nursing the tree are more expensive than the later years, the later years of growth taking place in passive environment (very little labor is expended per tree once it is in a large stock block). I would argue that one must add to the cost per tree attrition (due to disease, storms, accidents) spraying cost for herbicides and pesticides, unsalable stock due to misshapen growth, and other costs that reduce the salable stock as the tree grows larger. Therefore, the realistic cost of a hypothetical tree grown to advanced age while likely less per inch of diameter than a very young tree, is still in keeping with the cost of 3-inch nursery plant, which in nursery terms is at the large end of the salable stock size.

The disparity in valuation by the two methods is usual for humid temperate climates. In harsh climates where the growth is less vigorous, the valuation techniques derive much more similar numbers, and often the value by age produces a higher value than the volumetric method in areas such as deserts or hurricane riddled regions. Because of this, it is often argued that the lower value should apply due so as not to penalize the state for the excellent growing conditions or vice versa. I would argue that the best approach is the average value as this would generate consistent amelioration of numbers for vastly different conditions across a vastly different nation.

Important to this discussion is to answer the value question in reverse. How is possible that the valuation techniques used here could be wrong? Other minor adjustments for values in the equations, the resulting value based on actual commercial stock, and scientifically proven measures of volume and age will still result in a very high value for trees of this type. In short, it is not a matter to be taken lightly that the trees in question have stood for 222-365 years. They are very valuable by all reasonable measures.

Finally, the roadway widening in question could easily be changed to accommodate the trees. The entire west side of the roadway is an open pasture. Widening the road on that side of the roadway would harm nothing of value. The state should use the same standard that has been used in many other cases of this type. Avoid disturbance first, minimize damage second, then only if these methods do not suffice mitigate that loss of the natural habitat.

Sincerely,



John J. Sabuco, LLA
Ecologist
President
Eldertree, Stoneoak & Brookings, Inc.

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Tables & Figures

Table 1**Summary of Data**

Species	Height (ft)	Height (m)	Basal Area (sqft)	Basal Area (sqm)	Coefficient of Volume	Adjusted age (yrs)	V _D /V _N	A _E /A _S
							Vol. Factor of 3" nursery stock	Age Factor against 3" stock
Bur Oak 1	63	19.2	3.10	0.288	5.52	222	331	40
Bur Oak 2	65	19.8	3.43	0.319	6.31	236	378	43
Bur Oak 3	69	21.0	2.48	0.230	4.84	327	290	59
Bur Oak 4	74	22.6	4.15	0.386	8.70	293	521	53
Bur Oak 5	67	20.4	3.57	0.332	6.77	276	406	50
Bur Oak 6	60	18.3	2.31	0.214	3.92	249	235	45
White Oak 7	68	20.7	9.74	0.905	18.75	231	1124	42
White Oak 8	48	14.6	4.50	0.418	6.11	264	366	48
Bur Oak 9	56	17.1	5.71	0.530	9.05	289	543	53
White Oak 10	59	18.0	5.80	0.539	9.68	365	581	66
						Total	4776	500
3" Nurse Stock	12	3.7	0.05	0.005	0.02	5.5		

Note: Value assumes a replacement cost of \$350 per 3-inch nursery stock oak tree

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White Oak 8	48	14.6	4.50	0.418	6.11	264	366	48
Bur Oak 9	56	17.1	5.71	0.530	9.05	289	543	53
White Oak 10	59	18.0	5.80	0.539	9.68	365	581	66
						Total	4776	500
3" Nurse Stock	12	3.7	0.05	0.005	0.02	5.5		

Note: Value assumes a replacement cost of \$350 per 3-inch nursery stock oak tree

Table 1 Detail

Height

Species	in feet	line (%)	(%)	BSL*0.01	HSL*.01	Height (ft)	(m)
Bur Oak 1	100	3	60	0.03	0.6	63	19.2
Bur Oak 2	100	5	60	0.05	0.6	65	19.8
Bur Oak 3	100	3	66	0.03	0.66	69	21.0
Bur Oak 4	100	2	72	0.02	0.72	74	22.6
Bur Oak 5	100	3	64	0.03	0.64	67	20.4
Bur Oak 6	100	2	58	0.02	0.58	60	18.3
White Oak 7	100	4	64	0.04	0.64	68	20.7
White Oak 8	100	4	44	0.04	0.44	48	14.6
Bur Oak 9	100	5	51	0.05	0.51	56	17.1
White Oak 10	100	1	58	0.01	0.58	59	18.0
3" Nurse Stock						12	3.7

Basal Area

Species	Circum (m)	Diameter (ft)	(sqft)	(sqm)	of Volume	nursery stock
Bur Oak 1	1.9	1.99	3.10	0.288	5.5221	331.05
Bur Oak 2	2	2.09	3.43	0.319	6.3129	378.46
Bur Oak 3	1.7	1.78	2.48	0.230	4.8418	290.27
Bur Oak 4	2.2	2.30	4.15	0.386	8.6963	521.35
Bur Oak 5	2.04	2.13	3.57	0.332	6.7700	405.87
Bur Oak 6	1.64	1.71	2.31	0.214	3.9183	234.90
White Oak 7	3.37	3.52	9.74	0.905	18.7510	1124.13
White Oak 8	2.29	2.39	4.50	0.418	6.1118	366.41
Bur Oak 9	2.58	2.70	5.71	0.530	9.0507	542.60
White Oak 10	2.6	2.72	5.80	0.539	9.6840	580.56
3" Nurse stock		0.25	0.05	0.005	0.0167	
Total						4775.60
Value						\$1,671,250.00

Age

Species	Rings/ inch	Diameter (ft)	Radius (in)	Age/breast height (yrs)	Negative adjustment	Adjusted age @ Breast Height (yrs)	Age Factor against 3" stock
Bur Oak 1	19.61	1.99	11.91	234	-11.68	222	40
Bur Oak 2	19.86	2.09	12.54	249	-12.45	236	43
Bur Oak 3	32.25	1.78	10.66	344	-17.19	327	59
Bur Oak 4	22.37	2.30	13.79	309	-15.43	293	53
Bur Oak 5	22.71	2.13	12.79	290	-14.52	276	50
Bur Oak 6	25.46	1.71	10.28	262	-13.09	249	45
White Oak 7	11.53	3.52	21.13	243	-12.17	231	42
White Oak 8	19.37	2.39	14.36	278	-13.90	264	48
Bur Oak 9	18.82	2.70	16.17	304	-15.22	289	53
White Oak 10	23.56	2.72	16.30	384	-19.20	365	66
Total							500.3845
Value							\$175,000.00

Sorted	Raw Age	ID	Height	BA	Adj Age
Final Data	384	White Oak 10	59	5.80	365
	344	Bur Oak 3	69	2.48	327
	309	Bur Oak 4	74	4.15	293
	304	Bur Oak 9	56	5.71	289
	265	Bur Oak 5	67	3.57	276
	264	White Oak 8	48	4.50	264
	251	Bur Oak 6	60	2.31	249
	249	Bur Oak 2	65	3.43	236
	243	White Oak 7	68	9.74	231
	234	Bur Oak 1	63	3.10	222

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Height

Species	in feet	line (%)	(%)	BSL*0.01	HSL*.01	Height (ft)	(m)
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Figure 1 Pearson Product Moment Correlation: Height Against Basal Area

$$\text{Height} = 63.176 - .0616 * \text{Basal Area}$$

Correlation: $r = -.0182$

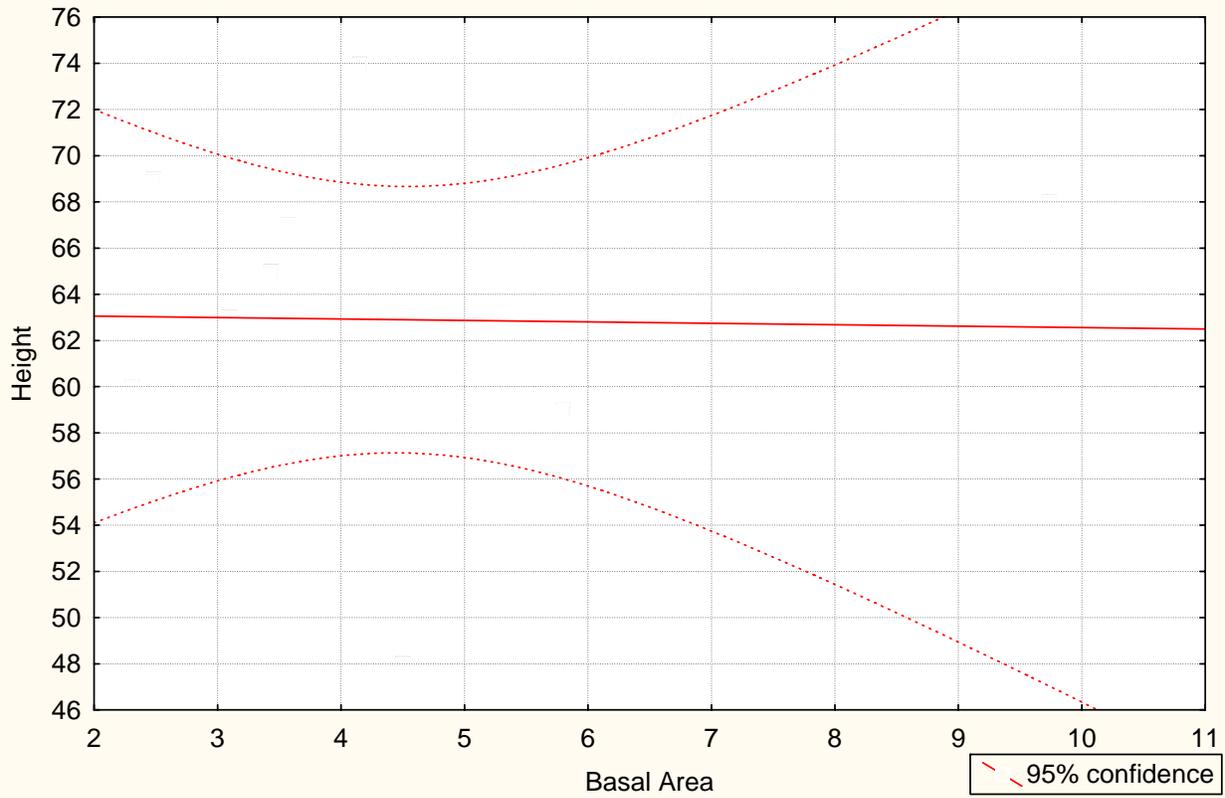


Figure 2

Negative Exponential fit to Array of Raw Age

$$Y = 379.6325 \cdot \exp(-0.0513 \cdot x)$$

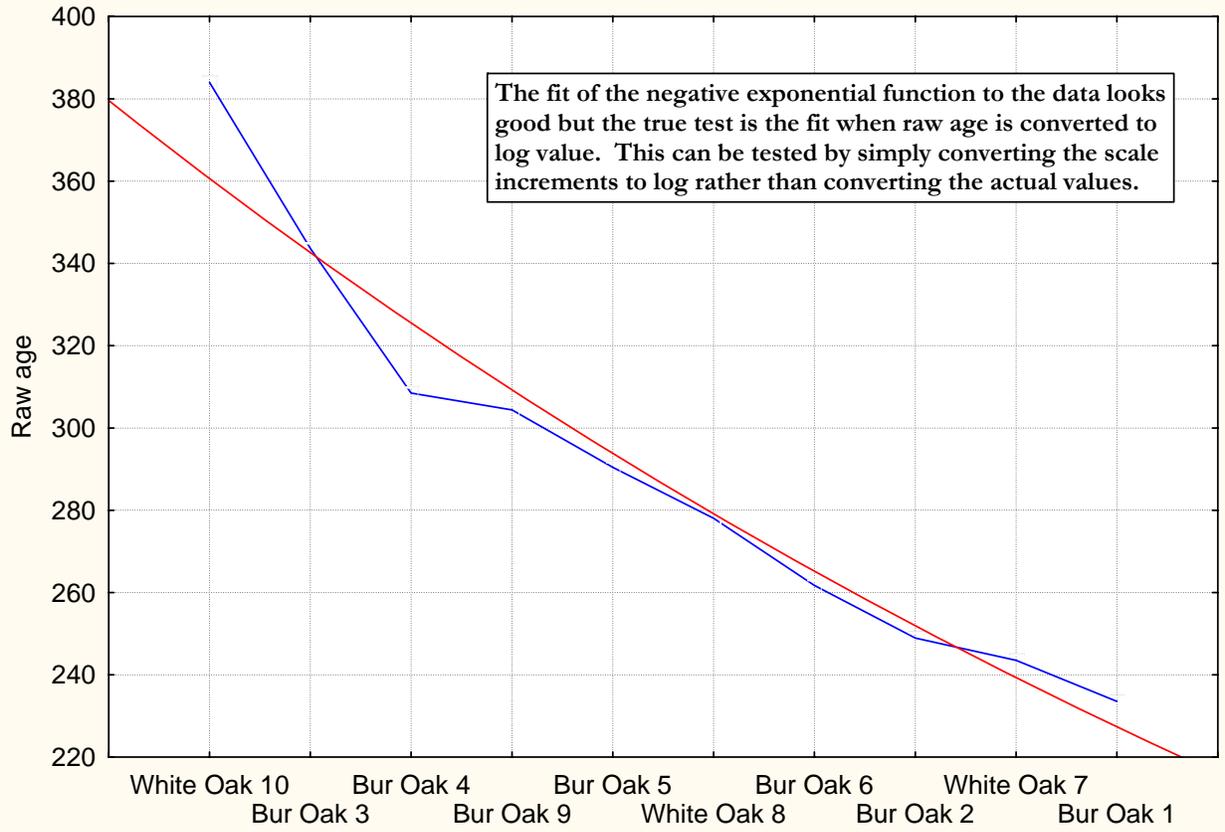


Figure 3

Negative Exponential fit to Array of Raw Age -- Log Scale

$$Y = 379.6325 \cdot \exp(-0.0513 \cdot x)$$

