Tree Height-Diameter, Diameter-age and Height-age Relationship in Northern Hardwood Forests

Trees grow both in diameter and height. The possible benefit of growing higher are better position of foliage for photosynthesis, creating of shade for competitors and favorable position to reproduce and disperse organs (Rich, Helenurm, Kearns, et al 1986). The annual diameter allow trees to remaining alive and erect in strong winds, ice storms and resist major losses of woody materials (Coder 1996). Given a limited energy income, trees have to allocate different proportion of energy to height growth and diameter growth. The relation between tree height and diameter at breast height (DBH) diameter has been studied since Meyer suggested the exponential height-diameter relationship: H= k + b 1 (1-e –b2 DBH), where k=breast height (4.5 feet (1.37 meter) aboveground level in the United State), and b I = coefficient (Lei et al. 2001). However, different tree species display in different height-diameter equations (Huang et al. 1992). Another notion is that trees grow at different rate at different age. It has been reported that tree diameters are also related to tree age (Leak 1985, Curtis 1967). David King also stated that tree height has a relation to the age (King 1989).

As is mentioned above, the tree height-diameter equations differ from species to species. Trees in Hubbard Brook Experimental Forests, Jeffers Brook Experimental Forests and Bartlett Experimental Forests contains variable tree species such as sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), white birch (*Betula* *papyrifera*), etc., which indicates we can pay attention to their height-diameter, diameter-age, height-age relations.

Objective 1: Examine the height-DBH relation for all tree species in Hubbard Brook, Jeffers Brook and Bartlett.

Hypothesis: There is a linear relation between tree height and DBH and different correlation coefficient between height and DBH varies for different tree species.

Objective 2: Examine the diameter pattern across different ages.

Hypothesis: The diameter is linearly related to age.

Objective 3: Examine the height pattern across different ages.

Hypothesis: The height is linearly related to age.

Research Plan

Study Site

The research will be conducted at the Hubbard Brook Experimental Forests, Jeffers Brook Experimental Forests and Bartlett Experimental Forests, where a series of experimental plots in replicated stands of different ages have been established. Species in these forests includes sugar maple (Acer saccharum), American beech (*Fagus grandifolia*), yellow birch(*Betula* *alleghaniensis*),white ash (*Fraxinus americana*) Pin cherry(*Prunus pensylvanica*), white birch (*Betula papyrifera*), and red maple (*Acer rubrum*) (Yanai 2009). We will study theses relations in early (19-24 yr) successional stands, young transitional (31-34 yr) and mature (>100 yr) stands.

Methods for the Objectives:

Step 1: Collect data and make tree inventory from May 17th ,2011 to June, 2011. The data is recorded in a preprinted sheet (Appendix I ).

Step2: Process raw data within MicroSoft Excel and build height-diameter, diameter-age, and height-age models in June,2011.

Step 3: Present the result in July,2011 at Scientists meeting.

Appendix I

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| Location | Site | Age | Plot | Subplot | Current tag # | Previous tag # | DBH at 1.35 m (cm) | Height (m) | Notes |
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References

Lei, Y. and B. R. Parresol. 2001. Remarks On height-diameter modeling. USDA Forest Service Research Note SRS-IO.

Rich, P.M., K. Helenurm, D. Kearns, S. R. Morse and M.W. Palmer. 1986. Height and stem diameter relationships for dicotyledonous trees and arborescent palms of Costa Rican tropical wet forest. Bulletin of the Torrey Botanical Club 113: 241-246.

Coder, K. D. 1996. Tree growth rate: Area Increase Table. University of Georgia Cooperative Extension Service Forest Resources Unit.

Huang, S. and S.J. Tius. 1992. Comparison of nonlinear height-diameter functions for major Alberta Tree species. Canadian Journal of Forest Research 22:1297-1304.

Leak, W.B.. 1985. Relationships of tree age to diameter in old-growth northern hardwoods and spruce-fur. US Forest Service Research Note NE-329.

Curtis, R. O.. 1967. Height-diameter and height-diameter-age equations for second-growth Douglas-fir. Forest Science 13: 365-385.

King, D. A..1990. The adaptive significance of tree height. American Naturalist 138: 809-828.

Yanai, Ruth. 2009. Nutrient Co-limitation in Young and Mature Northern Hardwood Forests.