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Abstract

Three species of pines were sampled for stem analysis in stands of native and plantation origin on 11 soil series in the Upper Peninsula of Michigan. Comparisons were made between species for height-age growth, site index and basal area. Soil materials for the 11 soil series were sand but contained varying amounts of fine and very fine sands. Internal soil drainage ranged from well drained to somewhat poorly drained. Forest sites were found for native stands of jack pine (Pinus banksiana L.), red pine (Pinus resinosa L.), and white pine (Pinus strobus L.) on well drained to somewhat poorly drained soils. Plantation origin jack pine and red pine stands were sampled on well drained sands that may have supported hardwoods, or an agriculture enterprise, prior to planting. Best sites are thinned plantations on abandoned lands.

Introduction

Since the early 1930's, over thirty thousand (30,000) acres of state lands in the Upper Peninsula of Michigan have been planted to red and jack pine. The majority of these sites were idle lands which may have supported some type of agricultural enterprise after a conifer or hardwood cut. Age of the stands range from several years to forty-five years.

Random observation of the red and jack pine plantations using site index and growth intercept techniques (Alban, 1972) showed the following; plantation sites were one to two site classes better than stands of native origin for the same species, and jack pine had a better site index in stands of native origin than red pine. We found that plantation stands did not occur on similar soils as native stands.

The better site indices of plantations over native stands is of importance to forest managers. Of primary concern: should an existing monotype such as jack pine be replaced by species of better economic value such as red pine, if indeed plantations reflect a superior growth rate, and secondly, the danger that a species may become susceptible to one or more insect and disease attacks that an alternate species may be desired.

A study was begun to evaluate the site index differences between jack and red pine in stands of native and plantation origin. A third species, white pine, was added to the sampling since it was found to occur with jack and red pine in many native stands.

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Methods

The study area is confined to the Upper Peninsula of Michigan, on Michigan Department of Natural Resources State Forest Lands. Initial selection of a stand for study was based on a visual cruise for uniformity of land form, soils, stocking and species composition. Sites which were very hilly, or contained numerous depressions, indicating water table problems, were not sampled. A temporary circular plot of 1/10 acre was installed in a stand which reflected the average condition of stocking and composition.

On each plot a minimum of two well formed trees of dominant, or co-dominant crown size of either red, jack or white pine were selected for stem analysis. Trees were cut and sectioned according to procedures outlined by Spurr (1952), Spurr (1956), and Hurch (1963). Basal area values were obtained with a 10 factor Bitterlich prism at plot center. Four other basal area observations were collected at the four cardinal points (North, East, South and West) on the parameter of the plot.

A soil pit was dug within each plot to facilitate classification according to procedures of the National Cooperative Soil Survey. The plot was checked for uniformity of the soil series at each of the main compass points, at a distance from the edge of the plot equal to the height of the edge tree. Topographic features measured were slope percent, relative plot position on the slope, and aspect.

Multiple regression methods were used to construct height-age curves for each species according to stand origin and management. Regression equations which had the highest r^2 value were adopted. Equations containing logorithms, reciprocals, linear and polynomials of height and age, or combinations of these elements, were tested. The soils encountered in this study are briefly described as follows:

Omega, and Graycalm soils are well drained sandy soils which have been developed in materials of glacial outwash origin. Omega soils have a provisional classification of Entic Haplorthods, and Graycalm soils are Alfic Udipsamments. The soil profiles have thin A1 or A1 and A2 horizons and dark reddish brown B21 horizons, suggesting a weak spodic horizon. Graycalm soils have a slightly finer B horizon and thin reddish brown lenses below the B horizons.

Rubicon, Vilas, Croswell, and Seney soils are well drained Entic Haplorthods which developed from sands of outwash plains and moraines. They have spodic horizons which can be recognized in the field, weakly cemented ortstien chunks may be present below the spodic horizon. Vilas soils are redder in the C horizon than Rubicon, Seney or Croswell soils. Seney soils have a thicker, slightly cemented B21hir horizon and Croswell has mottling between 20 and 30 inches.

Montcalm soils are well drained loamy sands which have developed in glacial outwash and morainic deposits. Montcalm soils are Alfic Haplorthods which have lenses of sandy loam, 1/2 - 1 inch thick, below 30 inches in the profile.

Kalkaska soils are well drained Typic Haplorthods developed in sands of outwash plains and moraines. Kalkaska soils are well developed spodosols with a distinct spodic horizon including B21hir and B22ir horizons.

Au Gres soils are somewhat poorly drained sandy soils of outwash plains and moraines. Au Gres soils are classified Entic Haplaquods. They occur in low areas of the landscape in which water tables may occur between 14 and 24 inches during the growing season.

Deer Park soils are well drained Spodic Udipsamments which have developed on stable sand dunes adjacent to Lakes Superior and Michigan shorelines. Deer Park soils have weakly developed horizons which can be recognized in the field. They have a more uniform and slightly finer sand texture than Rubicon and Vilas soils.

East Lake soils are well drained Typic Haplorthods developed in loamy sands over alkaline sands and gravel materials on outwash plains and abandoned glacial lake terraces. East Lake soils have a distinct spodic horizon including B21hir and B22ir horizons.

Results and Discussions

The data presented in Table 1 compares all sites that have been sampled. Sampling sites on the Rubicon, Croswell, Vilas and Deer Park soils, included all three species. Monotype stands were sampled for red and jack pine on Au Gres soils and for thinned red pine on Deer Park. Mixed and monotype red and jack pine plantation stands were sampled on Kalkaska and Seney soils.

Comparison of site indexes between these three pines from native stands shows a considerable range in growth (Table 1). Generally, jack pine has a better site index on these sandy soils than either white or red pine, and red pine has slightly better growth than white pine. A thinned native red pine stand was sampled on a similar site. It had 1/2 of a site class higher than unthinned native stands.

Unfortunately the stocking of these native sites had extreme variation with basal areas ranging from a low of 50 square feet per acre for jack pine on Au Gres soils to 150 square feet per acre for white pine on Vilas soils. There is a general trend of better growth as basal area increases for these three species in stands of native origin. Jack pine, however, shows reduced level of stocking on the wetter Croswell and Au Gres sandy soils with better growth than the associated species with higher levels of stocking.

Comparisons of red and jack pine growth in plantations shows better growth than for native stands, even with similar stocking. The soils associated with the plantation sites are better developed and the stands are managed more intensively. Furthermore, inspection of these sites revealed them to be abandoned lands that may have been either farmlands, or idle cutover hardwood and pine lands. Red pine of plantation origin has a 1 to 2 site class increase in growth over stands of native

TABLE 1. Comparison of selected stand properties for White, Red and Jack Pine by soil and treatment.

Soil Series	Species	Stand Origin & Composition	Site Index[1/]	Ht.	Age	Basal Area (Sq.Ft./acre)
Rubicon	White Pine	Native mixed[2/]	44	48	72	87[3/]
	Jack Pine	Native mixed	63	64	53	147
	Red Pine	Native mixed	45	54	61	95
Croswell	White Pine	Native mixed	52	68	60	90
	Red Pine	Native mixed	43	52	61	90
	Jack Pine	Native mixed	50	50	44	66
Vilas	White Pine	Native mixed	56	68	71	149
	Red Pine	Native mixed	43	68	71	90
	Jack Pine	Native mixed	62	54	40	88
Deer Park	White Pine	Native mixed	43	53	62	121
	Red Pine	Native mixed	46	54	59	107
	Red Pine	Native (thinned) Monotype	51	69	62	95
	Jack Pine	Native mixed	47	58	52	105
Au Gres	Red Pine	Native monotype	47	52	46	103
	Jack Pine	Native monotype	54	44	39	50
East Lake	Red Pine	Plantation(thinned) monotype	75	62	41	136
Kalkaska	Red Pine	Plantation(thinned) mixed	71	50	35	100
	Jack Pine	Plantation(thinned) mixed	62	50	35	100
Seney	Red Pine	Plantation(thinned) monotype	63	53	41	118
	Red Pine	Plantation(unthinned) mixed	58	39	32	126
	Jack Pine	Plantation(unthinned) mixed	61	48	32	129
	Jack Pine	Native monotype	50	66	61	
Montcalm	Jack Pine	Native monotype	52	59	62	146
Graycalm	Jack Pine	Native monotype	50	62	64	100
Omega	Jack Pine	Native monotype	46	52	55	80

[1/] Site Index curves for some forest species in the eastern United States (revised). Prepared by Eastern Region Forest Service, U.S.D.A., Upper Darby, Pa. 1965.

[2/] A mixed native stand for this study is one in which red, white and jack pine were sampled for comparisons on the same plot. A mixed plantation stand contained only red and jack pine.

[3/] Average of five observations collected on each plot with a 10 factor Bitterlich prism.

origin. The plantation sites were on soils with stronger profile development than native stands. This could account for the better site indices compared to native stands (Shetron 1974).

Since all but a few of the sites were a mixture of two or three of the conifers the question arises as to whether one of the species may have suppressed the height growth of another. For example, jack or red pine may have outgrown white pine in native stands keeping white pine as a subordinate crown class. The implication here is the suppression of one conifer by another. On all native sites sampled, white pine is the oldest member of the stand with jack pine the youngest. The possibility exists that red pine is suppressed to some extent, and that its true potential growth in native stands is masked compared to a pure stand on the same soil. We found very few native, pure, red pine stands, except for the thinned native stand on Deer Park soils. For plantation stands this relationship does not reveal itself as strong as in native stands. Perhaps as the plantation stands mature, between species competition will become more pronounced.

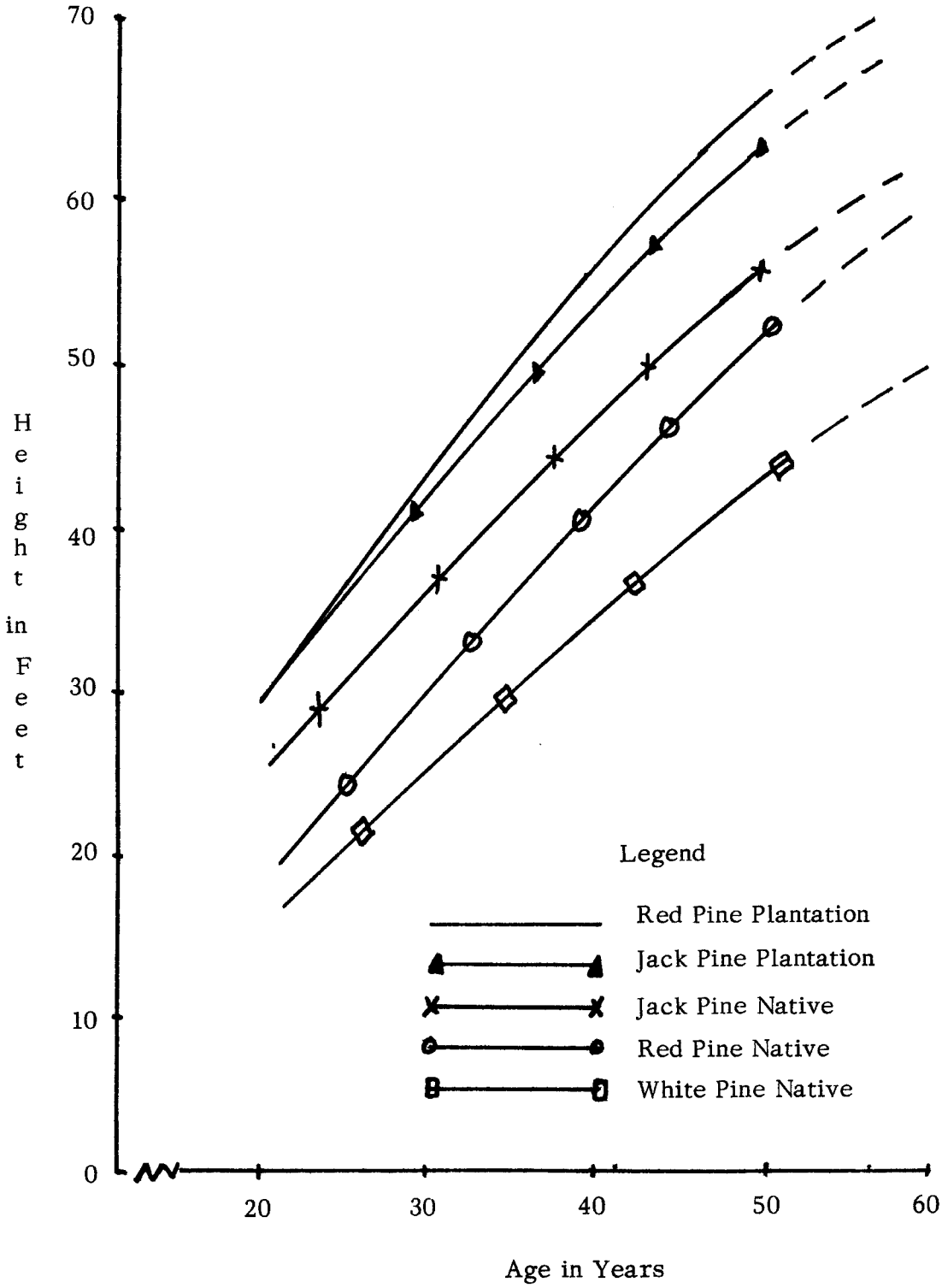
For each of the tree species studied regression analysis was employed to illustrate the functional relationships of height and age, without soil or site factors. This is because age has been strongly correlated with tree height in soil-site studies for these species and stand origins (Hannah 1971, Spurr 1952, Beck 1971). Age constitutes a large proportion of the total variation in height growth.

Figure 1 shows the height-age regressions for jack, red, and white pine by stand origin. The following equation $Y(HT) = a+b(x) + c(x)^2$ where X = age, had the highest R^2 values of all equations tested. The equations show the average growth for an average of all soils and sites sampled. As with site index, jack pine shows the best height-age relationship in native stands, with white pine the poorest. The curve shapes for the various stand origins indicate further meaningful trends. The white pine curve shape shows deaccelerated growth past age 50 indicating a less height growth per unit of age compared to jack and red pine. Red pine, however, shows a trend to surpass jack pine in height past age 60. None of the height-age curve shapes appear to equal, or cross over, the plantation curves.

Within the limits of the data collected thus far, one may conclude from the stem analysis data that jack pine should be favored over red and white pine on those soils in which these species are mixed in stands of native origin. However, release of red pine in native stands (Deer Park soils, Table 1) is desirable if pure native stands are to be maintained for timber production.

Properly managed red or jack pine plantations could be substituted for existing stands of native origin on similar soils. White pine compares so unfavorably with red and jack pine that it would probably be regarded as economically unimportant for long term timber production. An exception to this would be sites similar to the Vilas soils (Table 1).

Figure 1 - Height-growth curves for jack, red and white pine from representative stands of plantation and native origin.



Summary and Conclusions

Comparisons in site index between jack, red and white pine mixed stands of native origin have revealed that jack pine has better site indices than red or white pine. White pine is the oldest member while jack pine is generally the youngest. This may account for the poorer red pine site indices on the same site as jack pine. Low site indices for these species can be expected on dry sandy soils such as Omega, Deer Park and Rubicon. Soils with better soil moisture regimes have the better site indices (Shetron 1974, Stratton and Struethemeyer 1966).

Compared to stands of native origin, both red and jack pine have higher site indices in managed plantation stands. Whether this is a reflection of management or the fact that these may have supported presettlement forests other than red, jack or white pine needs further investigation. Unfortunately, plantations were not sampled on similar soils as the native stands. Whether or not the height-age relationships of plantations vs native stands would be greater requires further investigation.

Literature Cited

Alban, D. H. 1972 An Improved Growth Intercept Method for Estimating Site Index of Red Pine. U.S.D.A. Research Paper NC-80 7 pp.

Beck, D. E. 1971 Polymorphic Site Index Curves for White Pine in the Southern Appalachians, U.S.D.A. Forest Service Research Paper SE-80 8 pp.

Hannah, P. 1971 Soil-Site Relationships for White, Scotch, and Red Pine Plantation in Vermont. Vermont Agr. Exp. St. Bull. 667 27 pp.

Hurch, B. 1963 Forest Mensuration and Statistics, Ronald Press. 474 pp.

Shetron, S. G. 1974 Distribution of Free Iron and Organic Carbon as Related to Available Water in Some Forested Soils. S.S.S.A. Vol. 38: 359-362.

Spurr, S. H. 1952 Forest Inventory, The Ronald Press, New York

Spurr, S. H. 1955 Soils in Relation to Site Index Curves, In Proc. Soc. Amer. Forestry Meeting, Portland, Oregon 80-85 pp.

Stratten, K. G. and R. A. Struehtemeyer 1968 Evaluation of Soil Sites for White Pine in Maine, Maine Agr. Exp. Sta. Bull. 32 17 pp.