ABILITY OF SITE INDEX TO DIFFERENTIATE MERCHANTABLE YIELD IN SOUTHERN YELLOW PINE PLANTATIONS

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ABSTRACT

This study examines if site index (SI) temporally consistently ranks a site's ability to produce a particular product for loblolly, slash, and longleaf pine. Each plot by species was considered as representative of a different stand. Total height and diameter at breast height were measured and yield in tons were subsequently estimated at ages 8, 25, and 39. The SI of each plot and product yields by plot were ranked and examined for correlations at a particular age and for consistency across time. Total yield and SI rankings were strongly linearly related within a particular age. Loblolly pine had the least amount of variability. Correlations of yields in tons and SI rankings for total and pulpwood tons generally decreased across time, particularly for slash pine. However, sawtimber production correlations increased across time. Loblolly showed the most consistency among SI and yield rankings across time for a particular product and age. Longleaf showed less variability relative to slash for all product classes but sawtimber.

INTRODUCTION

Including site quality in growth and yield models is essential for the prediction of future yields. Site quality estimates are used to help identify the applicability of management actions, or to determine the ability of a site to meet management objectives. Commonly used measures of site quality are site index (SI) (e.g., King 1966), ecological classification systems such as habitat typing, and more direct measures of soils and climate (e.g., Graney 1977, Harrington 1991). Conceptually, for a particular species, SI is a collective influence of soil factors and climatic conditions and when excluding extremes, SI is thought to be independent of stand density. However, studies have shown that genetics and stand density can greatly influence SI (e.g., Boyer 1983). Unless accounted for, factors such as genetics (McKeand and others 2006, Zhai and others 2015), fertilization (Subedi and others 2014, Tiarks and Haywood 1996), planting density (Akers and others 2013, Anto´n-Ferna´ndez and others 2011, MacFarlane and others 2000), and thinning (Ritchie and others 2012) all contribute to reducing the effectiveness of SI to differentiate sites as to their ability to produce yields of a particular species. Hence, SI is both advantageous and non-advantageous because it is a function of the existing trees—thus the existing genetics and management practices of the current rotation and previous rotations. However, it is often non-advantageous because it does not provide a direct explanation of site growing conditions. These issues associated with SI are widely known.

There are numerous definitions of trees to be included in the calculation of SI for tree species across the world (Anto´n-Ferna´ndez and others 2011, Burkhart and Tennent 1977, Cao and others 1997, Lenhart and others 1986, Ritchie and others 2012, Sharma and others 2002). Different definitions of dominant height have been proposed for southern yellow pines (*Pinus taeda* L.) in the Southeastern United States (Lenhart and others 1986) including the tallest 50 percent of trees per acre (Boyer 1983, Golden and others 1981), the tallest 55 percent of trees per acre (McTague 2008), and dominants and co-dominants (Amateis and Burkhart 1985, Cao and others 1997, Zarnoch and Feduccia 1984). Two of the three former definitions calculate dominant height using a fixed proportion of trees (sometimes referred to as predominant height) while the other estimates dominant height based on crown classes (often dominants and co-dominants). Top height, or some percent of the largest diameter trees, has also been used as a definition (Sharma and others 2002). Placing trees into crown classes requires additional inventory time and for some research datasets may not have been conducted (Golden and others 1981). Thus, it may be necessary to use a definition of dominant height other than crown class.

Others have noted problems with the consistency of SI across time. Sharma and others (2002) found that correlation with the initial SI measurement decreased as time passed. However, studies examining the consistency of SI across time to rank the productivity of plots to produce common commercial product classes have been minimal—particularly

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in relation to product classes such as pulpwood, chip-n-saw, and sawlogs.

The primary objective of this study was to determine how consistently SI ranks the productivity of plots for common southern yellow pine product classes across time. Loblolly pine (*Pinus taeda* L.), longleaf pine (*Pinus palustris* Mill.), and slash pine (*Pinus elliottii* Engelm. var *elliottii*) were analyzed.

METHODS

Data

Data used during this assessment is from a study located on the Harrison Experimental Forest, near Saucier, MS, about 25 miles north of Gulfport, MS. It had been stocked with second-growth longleaf pines before being clearcut in 1958-1959. The soils are well-drained upland, fine sandy loams in the Poarch series and the Saucier-Susquehanna complex. Slope varies from 0 to 8 percent on the gently rolling land (Schmidtling 1984, 1987).

One-year-old seedlings of loblolly, longleaf, and slash pine were planted at 10- by 10-foot spacing in 1960. Within each plot, there were 10 subplots, five cultural treatments applied to high specific gravity populations and five to average specific gravity populations. Four replications (or blocks) were established, each plot contained 100 measured trees, for a total of:

> 3 species x 4 blocks x 10 subplots x 100 trees per plot = 12,000 trees in the study

The five cultural treatments were:

> U-0—check, no cultivation and no fertilizer;
>
> F-0—cultivation, but no fertilizer;
>
> F-1—cultivation and a single application of 100, 21, and 42 pounds per acre of N, P, and K, respectively;
>
> F-2—cultivation and a single application of 200, 42, and 84 pounds per acre of N, P, and K, respectively; and
>
> F-4—cultivation and a single application of 400, 85, and 167 pounds per acre of N, P, and K, respectively.

Cultivated plots were cleared of all stumps and slash, then plowed and disked. Stumps, soil, and competing vegetation were not disturbed on check plots. Cultivation consisted of disking three times each season for 3 years after planting and mowing in the 4th and 5th seasons. Fertilizer was distributed with an agricultural spreader and disked into the soil in May 1961, 1 year after planting.

Tree height and diameter at breast height (DBH) were measured in 1968 (age 8), 1985 (age 25), and 1999 (age 39). Height was measured during the commonly used SI base age of 25 years—allowing for a direct estimate of SI at base age 25.

Calculation of Dominant Height and Weights

Since dominants and co-dominants were not classified in this study, SI was specified using one predominant height (the tallest half of surviving trees). A base age of 25 years was selected and since heights were measured at age 25, excluding measurement error, there is an estimate of the true SI for each plot.

Equations found in Lenhart and others (1987) were used to predict total and merchantable weights for loblolly and slash pines while those in Baldwin and Saucier (1983) were used for longleaf pine. Upper stem diameter outside bark (DOB)s of 8 inches, 4 inches, and 2 inches were assumed to represent sawtimber, chip-n-saw, and pulpwood merchantable classes, respectively. Minimum DBHs were 12 inches, 9 inches, and 4 inches for sawtimber, chip-n-saw, and pulpwood

Table 1—Summary characteristics of loblolly, longleaf, and slash pine plantations located in Mississippi planted at a spacing of 436 seedlings per acre

Species	Age	Total tons per acre				Pulpwood tons per acre				Chip-n-saw tons per acre				Sawtimber tons per acre				Tallest 50 percent (feet)			
		Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD
Loblolly	8	1	15	32	9.7	0	13	32	10.2	0	0	0	0	0	0	0	0	17	32	43	7.62
	25	6	33	69	19.0	5	33	68	19.1	0	17	50	16.3	0	4	20	5.6	38	56	74	10.71
	39	6	50	104	28.0	6	50	103	28.0	1	39	96	28.6	0	18	60	17.5	48	71	92	12.18
Longleaf	8	0	7	15	4.7	0	5	13	4.5	0	0	0	0	0	0	0	0	8	22	30	6.60
	25	6	42	90	19.4	6	41	89	19.3	0	16	40	13.4	0	1	8	2.2	47	60	69	5.72
	39	16	71	149	30.6	16	71	149	30.5	4	53	120	28.3	0	15	49	13.7	58	75	86	6.19
Slash	8	3	12	24	6.4	0	10	24	7.4	0	0	0	0	0	0	0	0	19	30	37	5.30
	25	20	41	63	10.8	20	41	62	10.9	0	16	43	12.5	0	1	9	2.8	47	62	72	5.80
	39	25	64	99	17.3	25	64	98	17.3	12	48	87	18.0	0	17	65	14.7	60	79	92	7.40

SD = standard deviation; Min = minimum; Max = maximum.

Pulpwood tons is to an upper stem diameter outside bark (DOB) of 2 inches for diameter at breast height (DBH)s of 4 inches and larger, chip-n-saw tons is to a DOB of 4 inches for DBHs of 9 inches and larger, and sawtimber tons is to a DOB of 8 inches for DBHs of 12 inches and larger. *n* = 40 for all three species and ages.

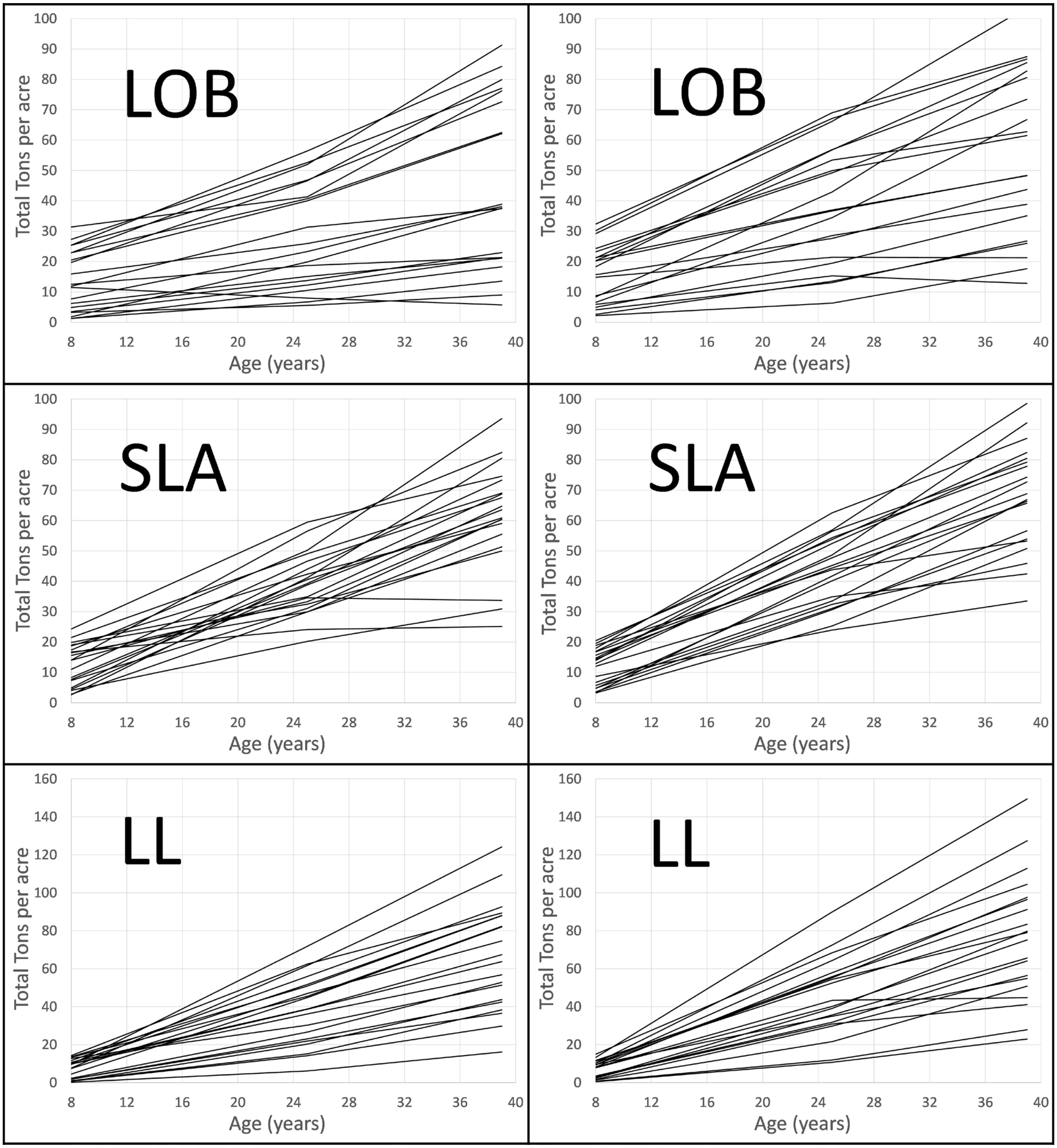

Figure 1—Total tons per acre at ages 8, 25, and 39, each subfigure contains 20 trajectories. The subfigures on the left are for blocks 1 (n = 10) and 2 (n = 10) by species, and the figures on the right are for blocks 3 (n = 10) and 4 (n = 10) by species. Note the different y-axis scales among the three species.

merchantable classes, respectively. Table 1 presents summary statistics and figure 1 contains total yield trajectories.

It could be argued that results in this paper are dependent to some extent on the particular volume or weight equations used—different equations may result in some differences in allocating total volume or weight among product classes. However, if this truly was an operational growth and yield study or the specific purpose was to estimate volume or weight, these sets of equations would be reasonable choices.

For this study the total predicted amounts of pulpwood, chip-n-saw, and sawtimber were analyzed separately, determined based only on minimum DBH and upper stem diameter specifications. Hence, no attempt was made to sort trees into various product classes that would be done during an actual timber harvest, and thus there was no need to calculate upper-stem pulpwood (topwood) on chip-n-saw and sawtimber "trees." For this analysis (table 1), for example, the pulpwood yield includes portions that could be merchandized as chip-n-saw or sawtimber. This approach is thought to be advantageous to determining the ability of SI to differentiate the capability of stands to produce a particular product class. For instance, are we interested in differentiating the ability of sites to produce pulpwood, or to produce upper-stem pulpwood (topwood)?

Analytical Procedures

It is desired of SI to rank stands based on their ability to produce merchantable weights. Merchantable weights were estimated at ages 8, 25, and 39 (since total tree heights and DBH were available). At each age, the relative ranking of each plot's total, pulpwood, chip-n-saw, and sawtimber weights was calculated, as well as the relative ranking of each plot's SI at age 25 (or predominant height at age 25). A ranking of 1 is the greatest value, or most productive, plot and a ranking of 40 is the smallest value, or least productive, plot for a particular variable.

For each plot, the yield ranking by product class at any age and its SI (predominant height at age 25) can be considered as being paired. The relative rankings of the plot yields across the different ages can be examined to see if indeed the predominant height rankings provide consistent information about merchantable volumes and tons throughout a rotation. The concept here is that if indeed SI (predominant height) across time is strongly correlated with the ability of stands and plots to produce a particular product throughout a rotation, then the relative rankings of the plot yields should be consistent across time. However, if a plot has a relatively poor yield ranking (for this study a larger numerical ranking represents lower site quality) at age 8, but a relatively good yield ranking (for this study a smaller numerical ranking represents better site quality) at age 39, then SI (predominant height) is not a temporally consistent measure of the inherent productivity level of a site.

RESULTS AND DISCUSSION

Plot yield ranks were generally strongly linearly related to SI ranks (table 2). Thus, greater SIs generally indicated greater yields. Longleaf and slash pines had more variability in their correlations for a particular age than loblolly pine. Pulpwood production at age 8 is not overly meaningful. However, correlations at common potential rotation ages, particularly at age 25, are important. Correlations of yields and SI plot rankings for total and pulpwood yields generally decreased across time, particularly for slash pine. Loblolly pine total and pulpwood correlations remained high at ages 25 and 39.

Table 2—Correlation matrix of plot-level product class and site index (base age 25) ranks by age and species of loblolly, longleaf, and slash pine plantations located in Mississippi planted at a spacing of 436 seedlings per acre

Age	Product	Loblolly	Longleaf	Slash
8	Total	0.92364	0.78743	0.88968
	Pulpwood	0.92008 (39)[a]	0.83752 (27)[a]	0.89268
	Chip-n-saw	–	–	–
	Sawtimber	–	–	–
25	Total	0.94371	0.55366	0.47992
	Pulpwood	0.94390	0.56735	0.49550
	Chip-n-saw	0.94522 (34)[a]	0.88931 (35)[a]	0.92364 (37)[a]
	Sawtimber	0.72233 (20)[a]	0.24353*(11)[a]	0.40356 (10)[a]
39	Total	0.89193	0.49925	0.28368**
	Pulpwood	0.89869	0.50432	0.29287***
	Chip-n-saw	0.90807	0.73096	0.63077
	Sawtimber	0.87186 (33)[a]	0.78518 (34)[a]	0.87842 (32)[a]

– = no ranking of plots.

[a]Number of plots with values greater than 0 for a particular product class.

Pulpwood tons is to an upper stem diameter outside bark (DOB) of 2 inches for diameter at breast height (DBH)s of 4 inches and larger, chip-n-saw tons is to a DOB of 4 inches for DBHs of 9 inches and larger, and sawtimber tons is to a DOB of 8 inches for DBHs of 12 inches and larger. n = 40 for all three species and ages by product. All correlations are significant at a p<0.0098 level, except *significant at p<0.1300, **significant at p<0.0761, ***significant at p<0.0667.

However, as expected sawtimber production correlations increased across time. Chip-n-saw correlations decreased from age 25 to 39, but of the three product classes, this class had the strongest correlations at age 25. To some extent the correlations may be artificially inflated because yield was not directly measured, but rather estimated using equations, which are a function of the observed heights. However, these correlation coefficients and this study do provide some indication of the relative ranking at one point in time in terms of management—which is useful.

Table 3 shows the average deviation by product class, age, and species between the SI and product class yield rankings of a particular plot. Except for sawlog tons at age 39, loblolly always had the lowest average difference and standard deviation. Consistent with the correlation results seen in table 2, loblolly pine generally had the strongest relationships between product class yield and SI rankings. For longleaf relative to loblolly pine, this seems logical given that longleaf pine survival and growth rates can often be erratic due to the "grass stage" and its particular biology (e.g., Haywood and others 2015)—perhaps important is that all seedlings in this study were bareroot, but given current regeneration practices, such as planting with container stock and better herbicides for weed control, longleaf may have reduced variability. The coefficient of variation is variable among the species, but it is uncertain if this measure of dispersion is of utility for this type of analysis.

Table 3—Average absolute (direction was ignored) difference in rank by product class, age, and species from the site index (base age 25) rank of a particular plot to that plot's product yield rank (Mean)

Product	Age	Loblolly			Longleaf			Slash		
		Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Total	8	3.6	2.8	76.5%	6.2	4.4	71.5	4.0	3.7	92.7
	25	2.9	2.7	93.2%	8.9	6.4	71.7	9.2	7.4	80.9
	39	4.6	2.8	60.9%	9.8	6.2	63.2	11.5	7.8	67.4
Pulpwood	8	3.7 (39)[a]	2.8	75.5%	5.2 (27)[a]	4.1	78.5	4.0	3.6	89.9
	25	2.9	2.6	92.9%	8.8	6.3	72.0	9.0	7.4	82.3
	39	4.4	2.8	63.6%	9.8	6.2	63.2	11.5	7.7	67.0
Chip-n-saw	8	–	–	–	–	–	–	–	–	–
	25	3.1 (34)[a]	2.3	76.4%	4.1 (35)[a]	3.6	88.0	3.2 (37)[a]	3.3	103.8
	39	4.1	2.9	71.2%	6.6	5.4	81.4	7.8	6.3	80.9
Sawtimber	8	–	–	–	–	–	–	–	–	–
	25	6.5 (20)[a]	5.7	87.8%	11.5 (11)[a]	8.5	74.3	10.1 (10)[a]	7.6	75.7
	39	4.9 (33)[a]	3.2	65.8%	5.7 (34)[a]	5.0	88.4	4.8 (32)[a]	3.1	64.5

– = no ranking of plots; SD = standard deviation; CV = coefficient of variation.

[a]Number of plots with values greater than 0 for a particular product class.

Pulpwood tons is to an upper stem diameter outside bark (DOB) of 2 inches for diameter at breast height (DBH)s of 4 inches and larger, chip-n-saw tons is to a DOB of 4 inches for DBHs of 9 inches and larger, and sawtimber tons is to a DOB of 8 inches for DBHs of 12 inches and larger. *n* = 40 for all three species and ages, and hence correlation ranks.

We may also be interested in the consistency between plot yield and SI rankings across time (fig. 2–4, table 4). For planning purposes, foresters are often interested in having a measure of site productivity that consistently ranks and differentiates sites across time. If there is substantial variability in yield production rankings among plots across time given their SI, then, in operation, a site's capability to produce yield at a particular age may be incorrectly determined to be relatively high or low because of its relative SI value being high or low.

Loblolly showed the most consistency among SI and yield rankings across time for a particular product and age (figs. 2–4, table 4) with the exception of total and pulpwood weights from ages 25 to 39. Longleaf pine showed less variability relative to slash for all product classes but sawtimber. For ages 25 to 39, sawtimber production showed the most variability across time. For total and pulpwood weights, ages 8 to 25 showed more variability in yield and SI-paired rankings relative to ages 25 to 39. Unfortunately, these results are tainted by relatively low production across all three species, many plots did not even have sawtimber at age 25 (table 2), and even some plots did not produce sawtimber at age 39, and hence, it is difficult to "define" their changes in ranks.

Table 4—Average absolute (direction was ignored) change in yield ranks by product class and species from ages 8 to 25 and from ages 25 to 39

Species	Projection	Total	All plots			Only plots with product yields		
			Pulpwood	Chip-n-saw	Sawtimber	Pulpwood	Chip-n-saw	Sawtimber
Loblolly	8 to 25	4.4	4.5	–	–	4.5 (39)	–	–
	25 to 39	3.0	2.8	2.7	6.3	–	2.5 (34)	3.5 (20)
Longleaf	8 to 25	5.8	7.3	–	–	8.2 (27)	–	–
	25 to 39	2.2	2.2	4.3	10.7	–	4.8 (35)	5.9 (11)
Slash	8 to 25	8.7	8.8	–	–	8.8 (40)	–	–
	25 to 39	4.8	4.9	6.6	10.0	–	6.6 (37)	5.0 (10)

– = no ranking of plots.

Pulpwood tons is to an upper stem diameter outside bark (DOB) of 2 inches for diameter at breast height (DBH)s of 4 inches and larger, chip-n-saw tons is to a DOB of 4 inches for DBHs of 9 inches and larger, and sawtimber tons is to a DOB of 8 inches for DBHs of 12 inches and larger. *n* = 40 for all three species and projections for the "All plots" average changes. For the Only plots with product yields average changes, numbers in parentheses are the number of observations used in the correlation analysis.

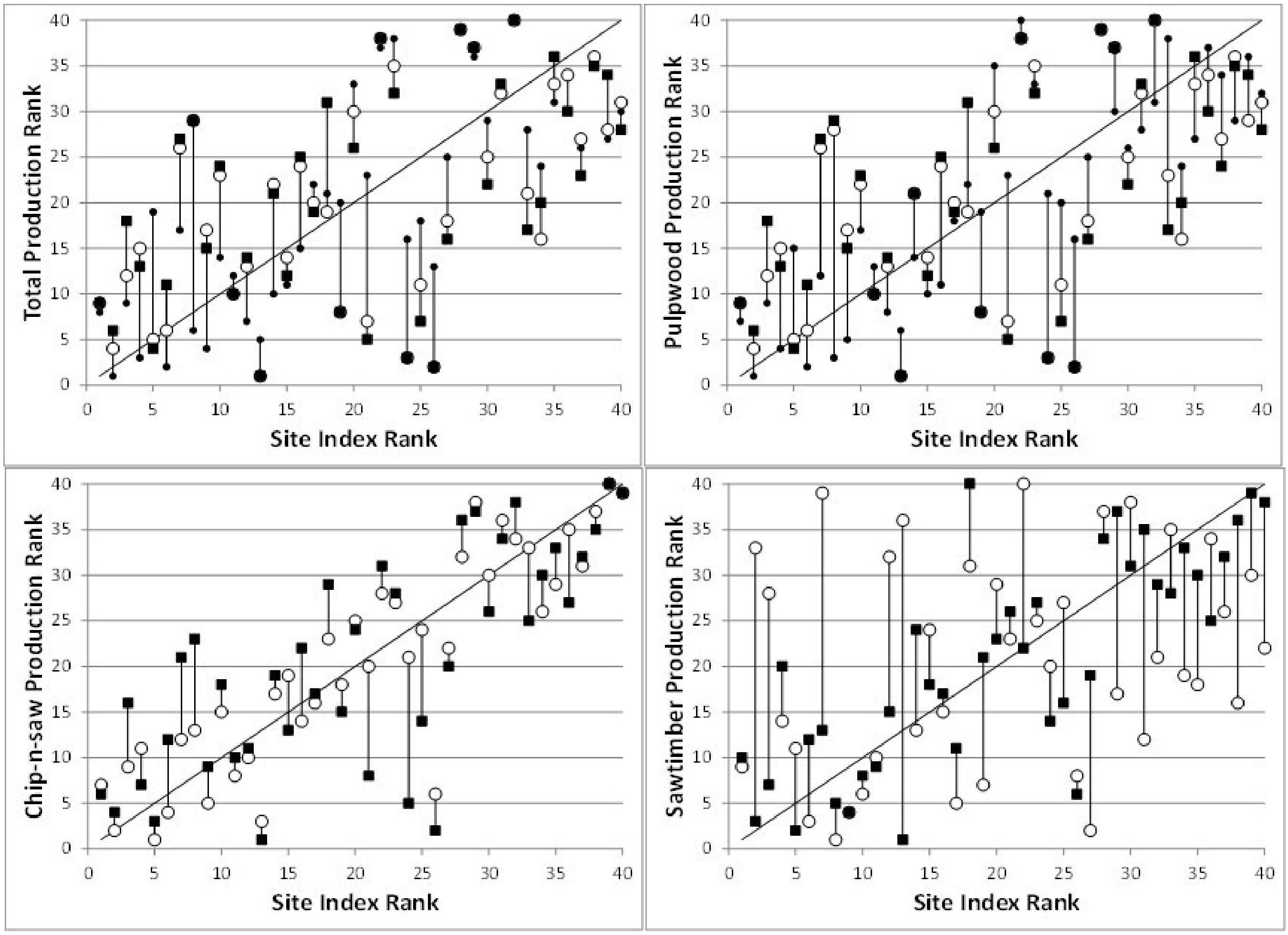

Figure 2—Ranks of the 40 longleaf pine plots by total, pulpwood, chip-n-saw, and sawtimber tons at ages 8, 25, and 39 over site index (base age 25) rank. The most productive site is 1, least productive is 40. Black filled circles are age 8, unfilled circles are age 25, and black filled squares are age 39. There are no age-8 values for chip-n-saw and sawtimber classes. *n* = 40 for each product and age. The black line is a one-to-one line.

One could analyze only those plots that had sawtimber at both ages 25 and 39, but that could eliminate the impacts of some, unidentified, biological limitation to using SI, such as why lower productivity sites eventually produced sawtimber at age 39. Table 4 also includes the change in yield rank across time for only those plots that had produced a particular product class at the younger age (Only plots with product yields). Although conducting this analysis had little impact on the relative relationship differences among species, when compared to the "All plots" analysis, absolute value changes in the relationships between sawtimber yield rankings (and hence SI) were substantially reduced for each species. For longleaf pine pulpwood at age 8, the change in ranks actually increased (7.3 to 8.2). This indicates that SI does distinguish low from high productivity sites, but, for example, does not always accurately distinguish the ability among sites that are considered to be highly productive. These results suggest that SI can essentially only tell you if a site has low or high productivity.

Self-thinning or the lack of self-thinning may play a part in the variability among paired rankings of yield and SI at ages 25 and 39. More productive sites may start competing with each other sooner for limited site resources, and if self-thinning does not occur, then chip-n-saw and sawlog production at older ages may not be as high as if self-thinning occurred. The lack of self-thinning may allow lower-quality sites to "catch-up" to the yields of the higher-quality sites with time; this could cause some variability in the relative status in yield production of stands across time relative to their SI ranking. The paired rankings may be more consistent through time if a thinning treatment(s) was applied. However, productivity was low for many plots on this site, regardless of species, likely due in part to a relatively low planting density, and it is difficult to say whether self-thinning occurred or not, and if it did, had any meaningful impact on results from this analysis.

There are a variety of SI definitions (Anto´n-Ferna´ndez and others 2011, Burkhart and Tennent 1977, Cao and others 1997, Lenhart and others 1986, Ritchie and others 2012, Sharma and others 2002). The ability to differentiate the capability of sites to produce a particular product may differ by SI definition. For example, perhaps for sawtimber

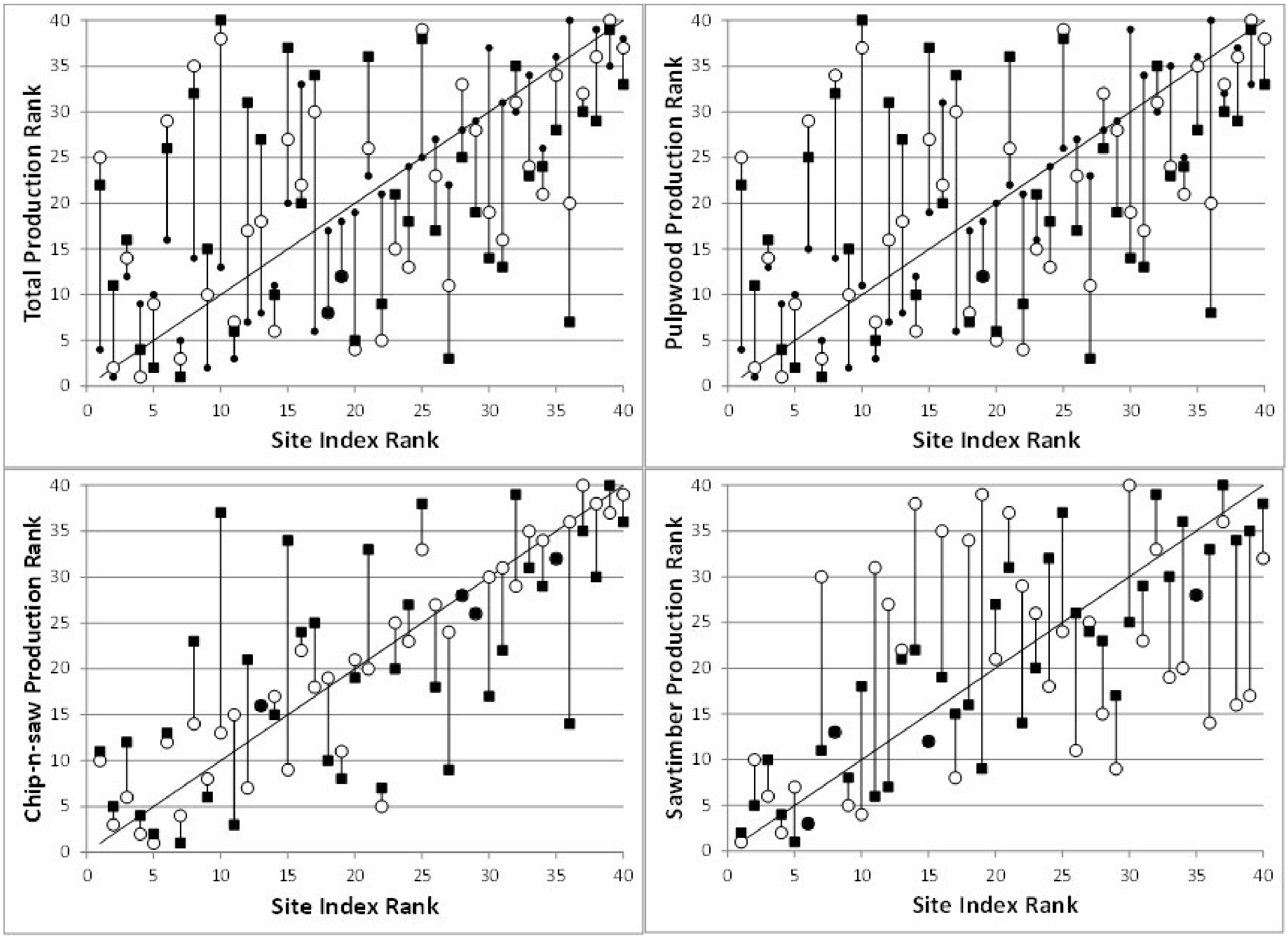

Figure 3—Ranks of the 40 slash pine plots by total, pulpwood, chip-n-saw, and sawtimber tons at ages 8, 25, and 39 over site index (base age 25) rank. The most productive site is 1, least productive is 40. Black filled circles are age 8, unfilled circles are age 25, and black filled squares are age 39. There are no age-8 values for chip-n-saw and sawtimber classes. $n = 40$ for each product and age. The black line is a one-to-one line.

yield, top height, or the average height of some amount of the largest diameter trees, may be better than using some type of height selection definition (e.g., predominant height or dominants and co-dominants). Further, top height may be better for sawtimber because of some artificially inflated correlation between sawtimber yield and different definitions of site quality since we are predicting yields (a yield equation) as a function of measured diameters and most often measured heights—sometimes even heights are predicted as a function of diameters. Future work should concentrate on seeing if different SI definitions have varying capabilities of determining the competitive status of plots and stands for a particular product class. As just noted, in most studies at least (except those where volume and weight are directly observed), a problem will be that stand volume and weight, or individual tree volume and weight, are predicted as a function of the observed heights, and thus there will likely be some artificially inflated correlation between those SI measures that are calculated using a larger number of tree heights, and volume and weight.

Oddly, determining the ability of SI, at a base age of 25, to rank the productive ability of sites is in part confounded with the impact of various management activities on other variables, such as survival and diameter growth. For instance, Haywood and Tiarks (2002), reported that dominant heights ranged from 39.4 to 40.2 feet and 45.6 to 45.9 feet at age 15, while cubic foot volume per acre ranged from 2,568 to 3,102 and 2,912 to 3,402, differing in levels due to varying mechanical site preparation, for loblolly and slash pine, respectively. In some ways it is good that dominant height was little affected by the mechanical site preparation treatments (disking and disking with bedding) because we have a consistent measure to compare this site to others, but since these treatments impacted survival, basal area, and ultimately volume, dominant height at age 15 (and SI at base age 25 estimated from it) is actually not a good measure of differentiating site productivity in this case. Kyle and others (2005) also showed inconsistencies to some degree for SI and volume production for sites receiving different site preparation and fertilization treatments. Bedding had the lowest SI (61 feet) and the lowest volume per acre (3,880

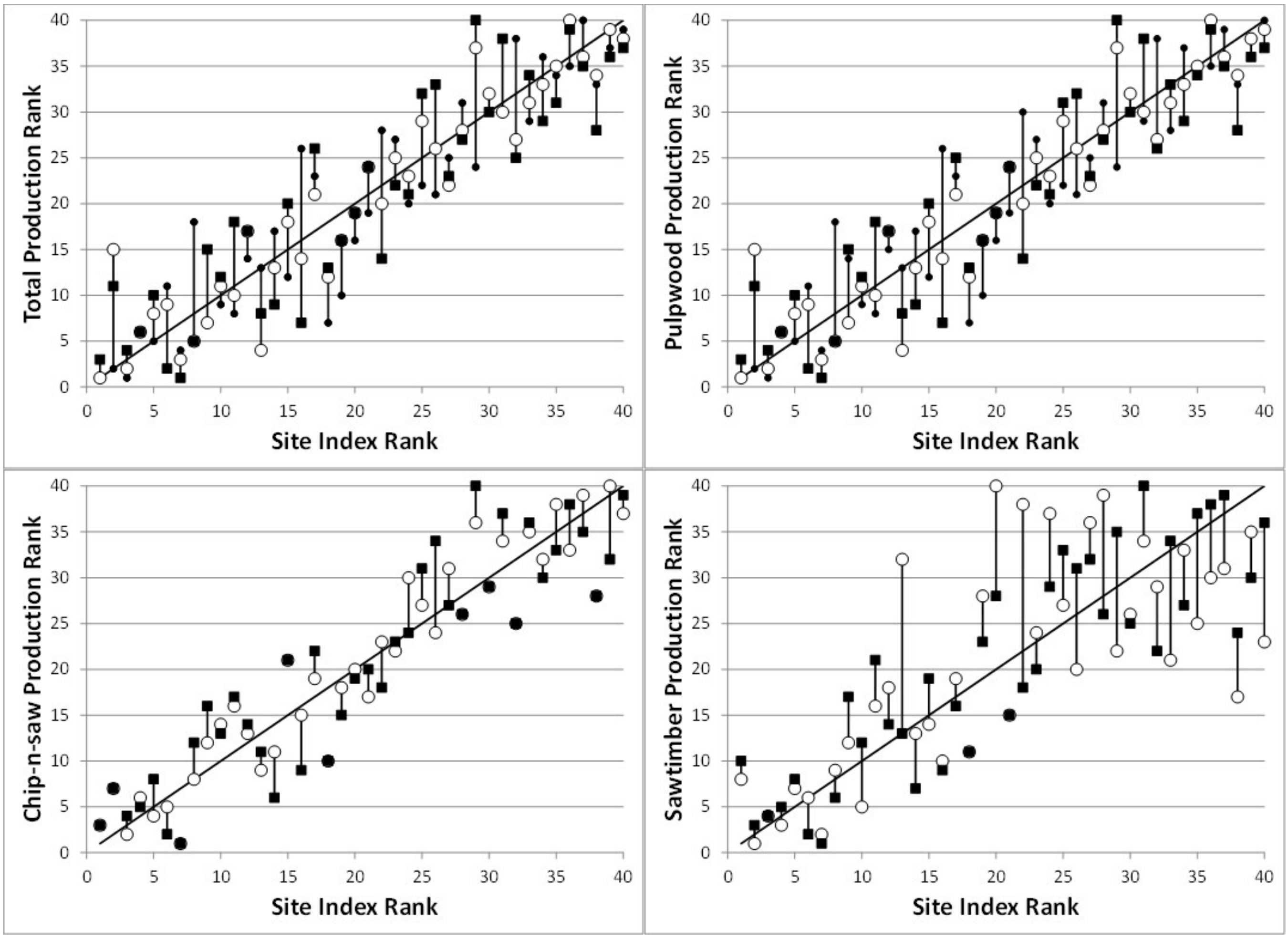

Figure 4—Ranks of the 40 loblolly pine plots by total, pulpwood, chip-n-saw, and sawtimber tons at ages 8, 25, and 39 over site index (base age 25) rank. The most productive site is 1, least productive is 40. Black filled circles are age 8, unfilled circles are age 25, and black filled squares are age 39. There are no age-8 values for chip-n-saw and sawtimber classes. *n* = 40 for each product and age. The black line is a one-to-one line.

cubic feet) at age 33, which is good, but chopping had a lower SI (66 feet) but higher volume production (4,846 versus 4,749) relative to ditching (68 feet). Some inconsistencies also occurred in the average volume and dominant height behavior across fertilization treatments.

One could argue that SI is a good measure of inherent site productivity, but not necessarily a good, or perhaps a better word is strong, measure of site productivity following the application of various silvicultural techniques. However, this is a whole other topic of study, and it may greatly depend on the definition of SI. For this study, it would be important to examine how the nitrogen, phosphorus, potassium (NPK) and cultivation treatments impacted the consistency of SI (base age 25) to rank the ability of plots to produce common product classes. However, we can view the experimental treatments in this study (e.g., NPK fertilization and disking) as creating different sites, and that we are in a way examining productivity on many different sites (while actually being at only one site). Hence, the results of this study are likely tainted because of the conflating (and thus confounding) impact of inherent versus enhanced site productivities, and which one of these site productivities do we want to use in specifying one site is more productive than another.

Longleaf pine eventually attained similar productivity levels as loblolly and slash pine and often exceeded their production (table 1, fig. 1). Similar results were seen in Outcalt (1993), and some treatments of this study at age 50 (Samuelson and others 2012). In terms of the utility of SI to differentiate among stands for a particular species, SI better differentiates longleaf pine than slash pine, but SI appears best for loblolly pine. Obviously, this conclusion is site dependent, and is likely even SI-definition dependent.

CONCLUSIONS

This study shows SI is not always consistent across time to differentiate a site's ability to produce certain products. Most of the results were as expected, but this study provides quantification of the errors, and hence quantitative evidence. The greatest variability was observed in slash pine while the least was observed in loblolly pine. This study is unique in that all three species essentially existed on the same site, and that the site exists in historic areas of all three species. Of course, different definitions of product classes, planting density, thinning, etc., would likely impact the results, as well as different definitions of SI. This study is another example of the importance of selecting a SI-base age that corresponds with the timing of management goals, such as final harvest, for SI to be a useful tool to differentiate the ability of sites to produce common wood products, particularly for longleaf and slash pine (table 2). Further study is needed to determine if SI (base age 25) always consistently ranks loblolly pine volume and weight productivity better throughout a rotation relative to longleaf and slash pine. Relative results in relation to SI's effectiveness among species on the same site may very well be dependent on genetic stock selected, planting density, thinning regimes, soil type, nutritive status, and control of undesirable vegetation.

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