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How Large is Large? Identifying Large Corporate Ownerships in FIA Datasets

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Abstract

Forest ownership size is a continuous variable, albeit one with a distinctly non-normal distribution. Although large corporate forest ownerships are expected to differ in terms of behavior and objectives from smaller corporate ownerships, there is no clear and unambiguous means of defining these two ownership groups. We examined the distribution of the ownership size variable and determined that approximately 11 percent of ownerships are statistical outliers in terms of total acreage owned. These ownerships differ significantly in terms of behavior (harvesting and tree planting) and objectives (timber) from smaller and medium-sized ownerships. Consequently, we suggest defining “large” corporate forest ownerships as those owning more than 45,000 acres of land, equivalent to the minimum acreage owned by statistical outliers in the ownership data.

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INTRODUCTION

The USDA Forest Service Forest Inventory and Analysis (FIA) program serves as the official survey of U.S. forests, providing information on forest structure, composition, and general ownership patterns. Through the National Woodland Owners Survey (NWOS), FIA collects additional data on the intentions, objectives, and motivations of private forest owners. This information is intended to provide a deeper perspective on how individual owners' attitudes and decisions may affect the nation's forest resources at aggregate scale. Private forest owners are categorized based on the type of ownership: corporate; non-governmental/natural resources organization; unincorporated local partnership/association/club; Native American (Indian); and individuals and families (Table 1).

Among corporate forest owners, a disproportionate amount of land is owned by a relatively small group of forest product companies, TIMOs/REITs, and other large corporate interests. It is hypothesized that the behaviors and outlook of these large corporate owners may be substantially different from smaller corporate owners, particularly in regard to a greater emphasis on management and production of forest products. Therefore, there is interest in developing a quantitative method for identifying large corporate owners. This information would be used to populate the INDUSTRIALCD variable in the Forest Inventory and Analysis database (O'Connell et al. 2016). This variable is intended to identify owners oriented toward

industrial timber production. These owners' total forest holdings should be of sufficient size to produce a continual flow of timber and, in addition, more often than not, there should be commercially-oriented forest management activities on at least some part of the owners' forest land. These owners include companies, organizations, and individuals that are generally considered by the forestry community to be part of the "forest industry" (regardless of whether or not they own mills or production facilities). One specific use of the INDUSTRIALCD variable would be for NWOS staff to target these owners with a specially designed survey tailored toward industrial forest owners.

Many of the largest industrial forest owners, including many established timber companies, can be easily identified based on expert knowledge. However, many cannot be so readily identified, particularly many holding companies and some TIMOs/REITs. Therefore, the most practical way to define large corporate forest owners using consistent methodology is to determine an acreage threshold above which a corporate forest owner will be considered to be a large corporate owner. The acreage owned by individual entities, however, is a continuous variable and the choice of where to place a threshold is highly subjective. In this paper, we explore the distribution of forest holdings in order to identify and justify an appropriate value for this threshold. We then test the basic hypothesis that owner behavior and management objectives differ above and below this threshold, by examining several variables taken from the FIA plot and NWOS datasets.

Table 1.—Private forest ownership categories used the U.S. Forest Service, Forest Inventory and Analysis (FIA) program (U.S. Forest Service 2012). Ownership codes represent the values recorded in the FIA database (O'Connell et al. 2016).

Ownership code	Ownership
41	Corporate, including native corporations in Alaska and private universities
42	Nongovernmental conservation/natural resources organizations Examples include Nature Conservancy, National Trust for Public Lands, Pacific Forest Trust, and Boy Scouts of America.
43	Unincorporated partnerships/associations/clubs Examples include hunting clubs that own, not lease property; recreation associations; 4H clubs; and churches.
44	Native American (Indian), within reservation boundaries
45	Individual and family, including trusts, estates, and family partnerships

METHODS

The basic FIA inventory is conducted using a stratified (by state) random survey design (Bechtold and Patterson 2005). For ownerships, this results in a probability-proportional-to-size sample design (Dickinson and Butler 2013). Individual states are divided into approximately 6,000-acre hexagons and a random point is selected within each hexagon. Plots within each state are separated into spatially tessellated panels, such that each panel (or group of panels) can be analyzed as an independent sample or the panels can be combined to provide more robust estimates. The panels are inventoried across 5- to 10-year periods depending on the state. After a complete cycle is completed, remeasurement of the plots commences. Using a combination of remote sensing and field observations, it is determined whether plots located at each of the randomly-selected points fall on forested land. For forested plots, ownership information is obtained and ownership categories are determined. An ownership is defined as a group of one or more owners that jointly owns a parcel of forested land.

For this analysis, we obtained ownership information for forested FIA plots that were part of panels inventoried in 2014 and 2015 ($n=25,129$ plots) in at least part of 49 states (data from Western Texas, Interior Alaska, and Tennessee were not available during those years). Data were first examined to ensure that ownership codes were correct and then filtered to include only those plots owned by corporate ownerships ($n=5,062$ plots). Using general methods developed by the NWOS (Butler et al. 2016), we then identified those plots which belonged to the same ownerships and estimated the total forest acreage owned by each ownership. Forest acreage was estimated by dividing the total land area (forested and nonforested) in each state by the total number of plots (forested and nonforested) in our dataset to derive state-level “expansion factors”. These expansion factors were then multiplied by the number of forested plots belonging to each ownership in each state and then summed across states to come up with a national total. The distribution of this variable was then explored graphically and quantitatively in order to identify an appropriate threshold for large corporate ownerships. Finally, we examined whether ownerships categorized above and below this threshold differed in terms of behavior and perspective using additional variables from FIA and the NWOS. For continuous

variables, we used ANOVA along with Tukey’s Honest Significant Difference (HSD) for means comparisons. For categorical variables, we used χ^2 analysis; individual differences were tested using Fisher’s Exact Test. Data analysis was conducted using R 3.2.3 (R Core Team 2015).

RESULTS AND DISCUSSION

We identified 2,488 unique corporate ownerships, each of which was represented in the data by 1 to 313 plot records. As expected, the total estimated forest acreage owned by each ownership followed a strongly skewed distribution, even when log transformed (Figure 1). We identified 280 outliers, defined as those ownerships whose forest holdings were greater than 1.5 times the interquartile range (IQR) (Tukey 1977). By assuming these outliers to be large corporate ownerships, we tentatively identified a threshold at 44,578 acres.

We examined several additional variables associated with the FIA plot data that measured landowner behaviors. One was whether or not the plot had been harvested in the last 5 years. The other was stand origin, in other words, whether or not the plot had

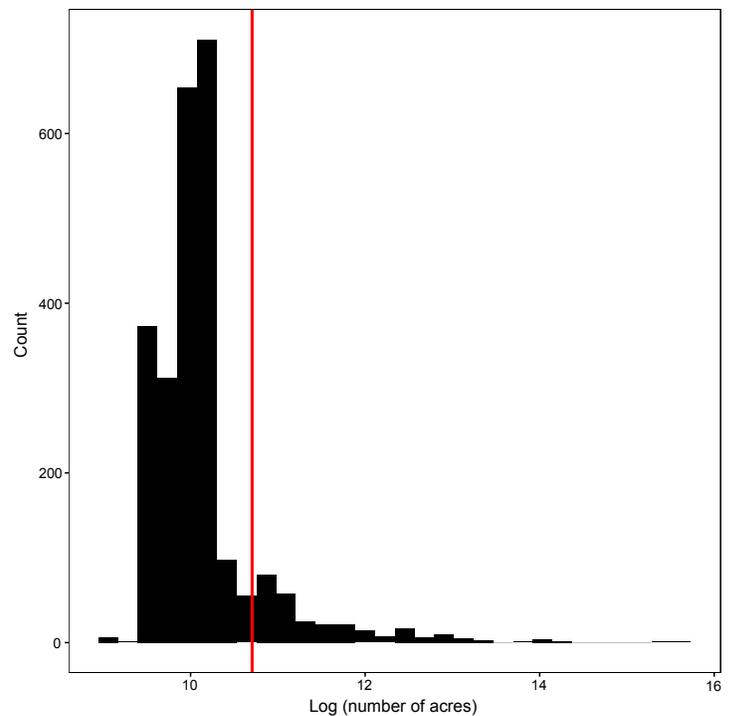


Figure 1.—Estimated forest holdings of corporate ownerships ($n=2,488$) in the United States. Data from U.S. Forest Service, Forest Inventory and Analysis database (O’Connell et al. 2016), 2014–2015. The red line separates outliers (defined as observations $>1.5 \times$ IQR) from the rest of the distribution.

been naturally or artificially regenerated (i.e., planted). The proportion of plots owned by an ownership that were harvested in the past 5 years differed significantly ($P=0.0029$) among outliers and ownerships within the four quartile groups. Outliers harvested a greater proportion of their plots (19.9 percent, $SE=1.4$ percent) than did smaller ownerships (13.5 percent, $SE=0.7$ percent) (Figure 2). Tukey's HSD was significant at the 0.05 significance level between outliers and ownerships in quartiles 1 ($P=0.0010$) and 4 ($P=0.0032$). The differences between the outliers and ownerships in quartile 2 ($P=0.2869$) and quartile 3 ($P=0.1398$) were not significant, nor were the differences among landowners in quartiles 1 through 4 ($P=0.1564$ to $P=0.9007$).

The proportion of ownerships' plots that were artificially regenerated was significantly higher ($P<0.0001$) among outliers (30.3 percent, $SE=2.1$ percent) than among ownerships in quartiles 1 through 4 (18.4 percent, $SE=0.8$ percent) (Figure 3). Tukey's HSD was significant at the 0.05 significance level between outliers and quartiles 1, 2, and 4 ($P<0.0001$) and significant at the 0.10 significant level between outliers

and ownerships in quartile 3 ($P=0.0511$). Compared to harvesting, there was greater variability in the intensity of planting in quartiles 1 through 4; the differences between quartiles 3 and 1 ($P=0.0315$) and quartiles 3 and 4 ($P=0.0181$) were both significant at the 0.05 significance level. This is likely due to statistical interactions between average size of holdings and forest type (deciduous vs. coniferous) and/or regeneration practices (natural vs. artificial), both of which differ on a regional basis across the country. Taken together, analyses of harvesting and planting suggest that corporate ownerships with appreciably larger acreages (outliers) engage in intensive management on a significantly greater proportion of their forest holdings than do smaller ownerships, lending support to the use of this threshold to define larger corporate ownerships.

Some corporate ownerships may own significant areas of forest land and yet be unlikely to engage in industrial forestry, particularly if that forest land is characterized by low productivity stands—as is the case with extensive ranches. To test the extent to which ranches and similar ownerships influenced our results, we re-analyzed the data using acres of timberland

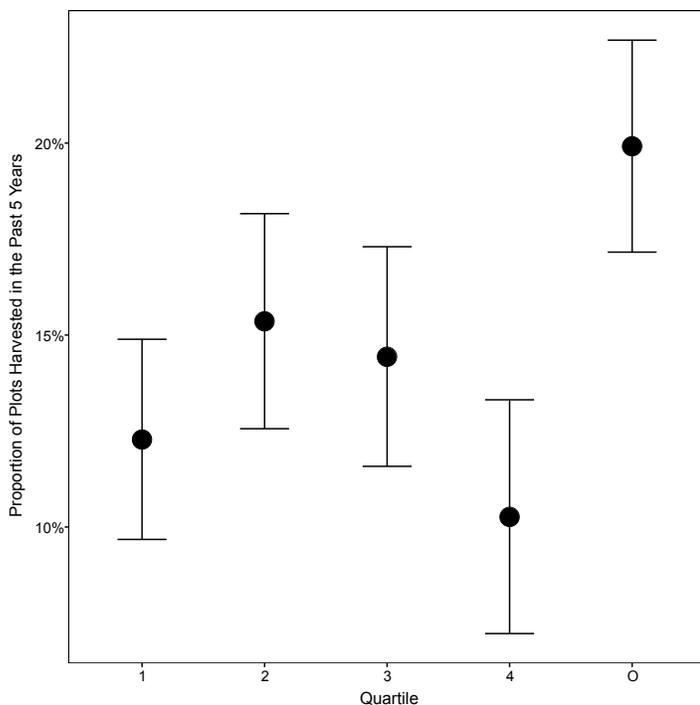


Figure 2.—Size of corporate ownerships ($n=2,488$) in the United States by the mean proportion of associated sample plots harvested within the 5-year period prior to sampling. Groups are defined according to the distribution of ownership size (acreage); outliers (O) are defined as observations $>1.5 \times IQR$. Data from U.S. Forest Service, Forest Inventory and Analysis Database (O'Connell et al. 2016), 2014–2015. Error bars are equal to two standard errors.

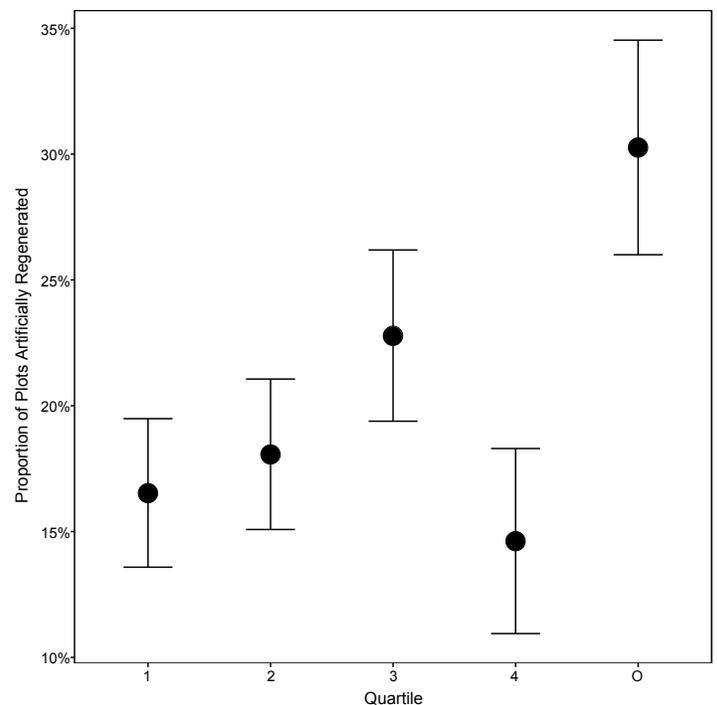


Figure 3.—Size of corporate ownerships ($n=2,488$) in the United States by the mean proportion of associated sample plots that were artificially regenerated (i.e., plantations). Groups are defined according to the distribution of ownership size (acreage); outliers (O) are defined as observations $> 1.5 \times IQR$. Data from U.S. Forest Service, Forest Inventory and Analysis database (O'Connell et al. 2016), 2014–2015. Error bars are equal to two standard errors.

(defined as forests capable of producing 20 cubic feet per acre per year) instead of acres of total forest land. Substituting timberland for forest land resulted in smaller differences between small and large landowners in terms of harvesting and planting behavior. The explanation for this is not entirely clear, but it appears that ownerships with large acreages overall are disproportionately more likely to engage in harvesting and planting activities on low-productivity forest lands than are smaller ownerships.

To test the sensitivity of our results to our methodology, we reanalyzed outliers using a range of multipliers. In addition to the standard $1.5 \times IQR$, we also used, $2 \times IQR$, $2.5 \times IQR$, and $3 \times IQR$ (sometimes called ‘extreme outliers’) (Tukey 1977). These additional multipliers resulted in acreage thresholds from 50,000 to 60,000 acres of forest land and outlier counts from 182 to 261 ownerships. In each case, however, the difference between the outliers and the 4 quartiles in terms of harvesting and planting behavior was unchanged. Consequently, we retained the use of the most common definition of outliers, $1.5 \times IQR$. For practical purposes, we would recommend rounding the value of the resulting threshold to 45,000

acres. In the 2014/2015 dataset, this rounded value results in the identification of an identical number of large corporate owners as the original value.

In addition to behavior, large corporate ownerships are hypothesized to differ from smaller ownerships in terms of management objectives. To test whether large ownerships think differently than smaller ownerships about their forest land, we obtained data from the 2013 iteration of the NWOS (Butler et al. 2016). Survey respondents ($n=1,365$ corporate responses) were asked to rate the importance of timber production (“For timber products, such as logs or pulpwood”) as a reason for owning their lands, on a scale from 1 (“Not important”) to 5 (“Very important”). Respondents were also asked how much land they own. We used this self-reported acreage as a partially independent test of the validity of our threshold. Each response was coded as a large or small landowner using the rounded value of the threshold, 45,000 acres. To test whether the frequency of each response differed across quartile groups, we constructed a 2×5 contingency table. As expected, the importance of the timber production objective differed between small and large ownerships (Figure 4); the value of the resulting χ^2 statistic was

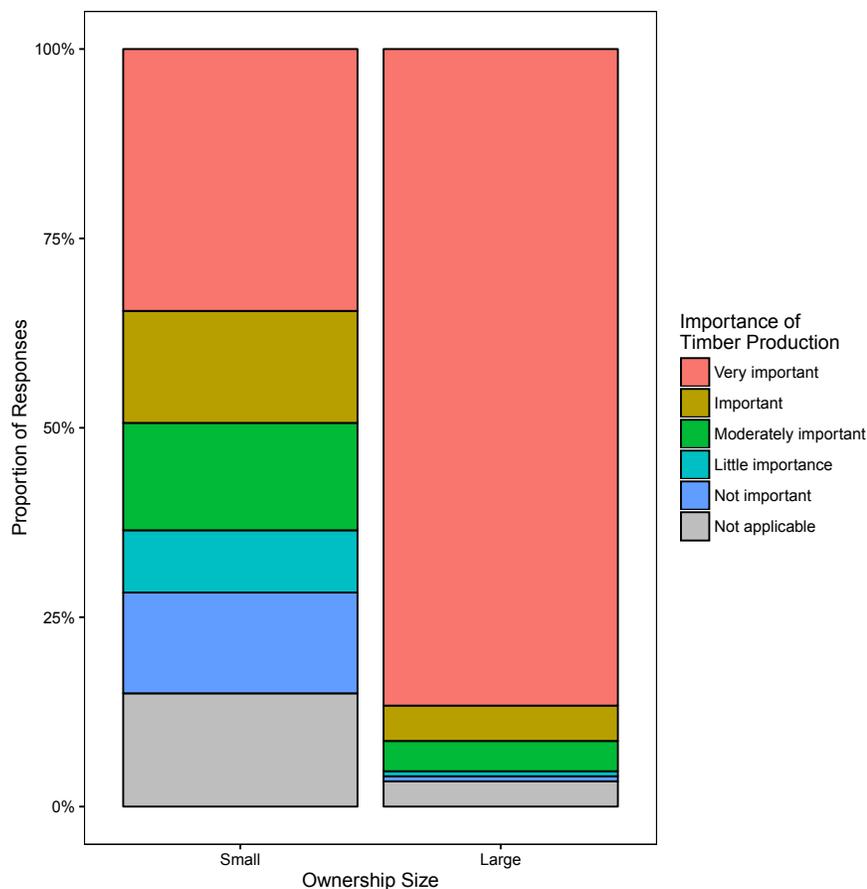


Figure 4.—Size of corporate ownerships ($n=2,488$) in the United States by importance attached to timber production as a reason for land ownership. Large ownerships are defined as ownerships owning more than 45,000 acres of forest land nationally. Data from U.S. Forest Service, National Woodland Owner Survey (NWOS) 2013.

significant at the 0.05 significance level ($P < 0.0001$). In order to understand which responses were driving this result, we combined responses into two broader categories, *important* (“Important”/“Very important”) and *not important* (all other responses) and used Fisher’s Exact Test on the resulting 2×2 contingency table to test the difference in response frequency between small and large ownerships. As expected, the frequency with which timber objectives were rated as important was higher among large ownerships, 86.8 percent vs. 32.9 percent ($P < 0.0001$). These results suggest that corporate ownerships with disproportionately large holdings consciously place a greater emphasis on production of wood products than smaller corporations, findings which are consistent with our analysis of large corporations’ behaviors.

These analyses suggest that large forest ownerships—defined as corporate ownerships with more than 45,000 acres of total forest land—are significantly more likely to engage in intensive forest management and to hold timber production as an important management objective, compared to smaller corporate owners. We conclude that this definition is suitable for initial identification of industrial ownerships within FIA for multiple purposes, including an NWOS instrument aimed at industrial corporate owners. Because ownerships’ acreages are not static, periodic reassessments should be made to determine when new large ownerships emerge or existing ones cease to qualify as large ownerships. We recommend conducting this reassessment no more frequently than every 5 years, the minimum amount of time needed to complete a full FIA cycle in any state (Bechtold and Patterson 2005). Finally, it is important to emphasize that an acreage threshold is a coarse means of identifying industrial ownerships. Although landowners of large areas are statistically more likely to engage in intensive management behaviors and to hold industrial perspectives, more than 13 percent of ownerships above the threshold do not consider timber production an important objective while more than 32 percent of ownerships below the threshold do. Future efforts should expand upon these methods in order to come up with a more individualized and fine-grained methodology for identifying industrial ownerships regardless of size.

CONCLUSIONS

Large corporate forest ownerships are expected to differ in behavior and attitudes from smaller ownerships. Based on the distribution of ownership size (i.e., total acreage of forest land), we propose defining a large corporate ownership as an ownership owning more than 45,000 acres of forest land. Analysis of FIA data suggests that large corporations, defined this way, differ significantly in terms of management behavior (harvest and planting) and outlook from smaller corporations. This increased emphasis on timber management and production accords with initially hypothesized differences between large and small corporate ownerships.

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KEY WORDS: forest ownership, industrial forestry, ownership size

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