Forest Policy Center

Internal
Working Paper Series
No. 127

Family Forest Landowners in the Southeast: A Diverse Group with Diversified Objectives

Indrajit Majumdar, Lawrence Teeter & Brett J. Butler

Respectively, Postdoctoral Fellow and Professor, School of Forestry and Wildlife Sciences, Auburn University, AL 36849 and Research Forester, USDA Forest Service, Northern Research Station, 210 Holdsworth Hall, Amherst, MA 01003. Dr. Majumdar is the corresponding author and can be reached at 334-844-8027; email: majumin@auburn.edu.

3223 SFWS Building Auburn, Alabama 36849

Family Forest Landowners in the Southeast: A Diverse Group with Diversified Objectives

Indrajit Majumdar[1], Lawrence D. Teeter[2]

School of Forestry and Wildlife Sciences, Auburn University, 602 Duncan Drive, Auburn 36849-5418, AL, USA

Brett J. Butler[3]

USDA Forest Service, Northern Research Station, 210 Holdsworth Hall, Amherst, MA 01003, USA

Abstract: The names used to describe the family forest owners have changed over time, but the inclination to treat/analyze them as a homogeneous class has been fairly common. This study characterizes the family forest owners in the three Southeastern states of Alabama, Georgia and South Carolina based on their feelings about forest stewardship and their stated reasons for owning forestland. Our study, using multivariate cluster analysis procedures, suggests that the family forest owner 'group' is in fact a diverse set of owners who can be grouped into three attitudinal types namely *multiple-objective*, *non-timber* and *timber* oriented. The *multiple-objective* ownership type was found to be the largest group (533 owners, 49.1%) with almost every 1 out of 2 family forest owners in the sample population belonging to this category. Owners belonging to the *timber* (319 owners, 29.4%) cluster had only timber management and land investment as strong motivating factors behind their forestland ownership, while owners

[1] Post-doctoral fellow, majumin@auburn.edu (334)-844-8027

[2] Professor, teeteld@aburn.edu (334)-844-1045

[3] Research Forester, bbutler01@fs.fed.us (413)-545-1387

belonging to the *non-timber* (233 owners, 21.5%) cluster value the non-consumptive uses of their forestland such as aesthetic values, biodiversity, recreation and privacy.

Keywords: family forest, cluster analysis, landowner motivation.

INTRODUCTION

Forests and forestry have played a significant role in the economic development and psyche of the South. Forests, which in pre-settlement times occupied nearly all of the land area of the South, now occupy only 56 percent ((Economic Research Services of the USDA Forest Service 2002) http://www.ers.usda.gov/Data/MajorLandUses/MLUsummarytables.pdf). Also, the changing composition and use of these forests have important implications for their timber and non-timber outputs. Some of these changes have resulted from forest conversions to agriculture, and subsequent reversions back to forest (Healy 1985) and permanent conversions of forest to urban land. Other changes occurred as fiber demand increased over time and harvested lands were replanted with pines. More recent is the recognition that forests provide significant amenity and recreational values, which may lead to reductions in harvest by non-industrial private forest landowners (Lee 1997).

While forests provide both market and amenity outputs, these outputs are not necessarily complementary. The dominant market output is timber, the harvest of which often conflicts with production of high-quality amenity benefits. Thus, the values held by private landowners for amenities play a role in influencing private forest management by changing the harvest date or amount of timber produced from any given stand.

With the unprecedented recent growth in the number of private forest landowners there is an increased need to research and investigate the motives of these landowners to manage their land for timber and/or non-timber use. Three broad categories of ownership constitute what we

consider private forestlands: family owned or individual owners, industrial ownership, and Timber Investment Management Organizations (TIMOs) or Real Estate Investment Trusts (REITs). While of these latter two are considered to be primarily in the business of forestland management for profit and invariably their management actions focus on timber harvests, the objectives of the former, individual forest land owners, still remain largely unknown. The individual and family forest landowners hold 42% of the nation's timberland (261.6 million acres) and 59% (127.6 million acres) in the South (Butler and Leatherberry, 2004). Given their numbers it is important to study their diverse objectives, goals and intentions for managing their lands for timber and/or non-timber purposes.

Substantial research has been done over the past few decades focusing mainly on ways to motivate the family forest landowners to practice active forest management to boost timber supply. The relationship between harvesting decisions and the characteristics of landowners (Binkley 1981) has been the focus of most studies on private forest management behavior. Pattanayak et al. (2002) reported that timber supply is a function of the endogenous distribution of forest inventory which is correlated with ownership type and management characteristics. However, the relationship between forest amenity characteristics and private forest harvest has not been well established. One feature of all of the studies, with some exceptions (Finley et al. 2006; Butler 2005; Kluender and Walkingstick 2000; Finley 2002; Green and Blatner 1986; Gramann et al. 1985; Young and Reichenbach 1987) is to consider individual private landowners as a homogeneous, single group with similar motivations. In reality, the validity of this assumption is questionable.

This article tests the hypothesis that family forest landowners form a heterogeneous group with differing motivations and goals for forest management, and that even when they face the same market environment their actions differ.

LITERATURE REVIEW

Using data from a survey of 146 Finnish landowners in Southern Finland, Kuuluvainen (1996) employed K-means cluster analysis to empirically identify four groups of non-industrial private forest landowners (NIPFs) based on their objectives as *multiobjective owners*, *self-employed owners*, *recreationists* and *investors*. Lewis (1979) and Kurtz and Lewis (1981) utilized Q-methodology to construct a taxonomy of family forest owners in the USDA Forest Service Eastern Ozarks region of Missouri and identified four attitudinal types which were identified and described as *timber Agriculturists*, *timber conservationists*, *forest environmentalists* and *range pragmatists*.

More recently, a survey of and subsequent cluster analysis of 866 family forest owners in Arkansas identified four distinct groups of family forest owners: *timber managers*, *resident conservationists*, *affluent weekenders* and *poor rural residents* (Kluender and Walkingstick 2000).

Kittredge (2004) suggests that market segmentation may provide a superior approach to outreach compared with the traditional methods that assumed a single more homogeneous group of family forest owners. Market segmentation allows the audience to be broken down into relatively homogeneous similar classes, and the needs and desires of each class can then be ascertained. With the ownership class identified, certain groups can be chosen as priority targets for specific outreach programs. For example, Broderick et al. (1996) grouped family forest owners in Connecticut based on their intentions concerning forest stewardship planning. The

groups consisted of those who intended to sell their land (*sellers*), those who had a stewardship plan or had protected their land (*planners*), those who intended to develop a stewardship plan (*intenders*), and those who showed little inclination towards stewardship planning (*non-intenders*). Finley et al. (2006) used segmentation analysis to delineate the private forest owners in Massachusetts into four segments and named them as *general cooperators*, *conservation cooperators*, *neutralists* and *non-cooperators*. Each of the segments represented distinct levels of interest of the private forest owners within a segment to cooperate for certain forest activities with other owners outside the boundary of their individual forest property.

Kendra and Hull (2005) used cluster analysis to group family forest owners who had recently purchased forestland in rapidly growing counties in Virginia. In this case, the typology was based solely on the owners' responses to survey items measuring forest ownership motivations. The resulting six types were then described on the basis of demographic, land ownership and management characteristics and labeled as *absentee investors*, *professionals*, *preservationists*, *young families*, *forest planners*, and *farmers*. This study serves as a very recent example of a typology of family forest owners for which the classification was based on purely psychological variables. Though this study is significant in exploring the motivations of new owners and their reasons for acquiring forestland it fails to validate the results due to the absence of data on any of the past actions of the owners and as such the connection between landowner attitudes and their probable management actions in the future could not be made.

Summarizing this section on the review of past studies, we see a lot of variation regarding their motivations and the management strategies they employ. Emphasizing the diversity of family forest owners in the South, Wicker (2002) stated, "available research information is insufficient to define an average private southern forest landowner."

LANDOWNER MODEL

A typical rational forest landowner is assumed to maximize his utility from his forest holding by equating his preferences for timber and non-timber values to the total capacity of the land to provide these two benefits given resource and budget constraints. Based on Vincent and Binkley's (1993) model for a single stand, the optimal point where the landowner will maximize his utility depends on the interplay of the production trade-offs (the combinations of timber and non-timber units that the stand can produce) and the consumption (psychic) trade-offs which are determined by the landowners' perception of the relative value of timber and non-timber products of the forest. Binkley argues that for a single stand, unless the relative price line is either 'too' steep or 'too' flat, the multiple use option is always superior and rejects the possibility of a corner solution where the landowner chooses either to produce *only* timber or *only* non-timber. We support Vincent's and Binkley's argument that the most plausible option for family forest landowners in general is to practice multiple-use forest management in absolute terms. We argue, however, that based on the psychic price (value) that individual landowners' perceive from non-timber benefits, which typically do not have any market price, the slope of the relative price (value) line can differ to such a degree that it may be possible to group/classify landowners' based on their motivation to manage for either *mainly* timber or *mainly* non-timber or both.

To illustrate our point consider three family forest landowners' A, B and C who own single forest stands where each stand can produce two products, timber (T) and Non-timber (NT). We assume a strictly concave production possibilities frontier (PPF) for each of the three landowners consistent with the usual microeconomic assumption of increasing opportunity costs as one produces more units of a product (see Figure 1). The landowners maximize their utility at

the tangential point between the PPF and the relative price (value) line such that landowner A produces A_T and A_{NT}, landowner B produces B_T and B_{NT} and Landowner C produces C_T and C_{NT} quantities of timber and non-timber (Figure 1). The object of this paper is to test the validity of the existence of similar family forest landowner groups in the Southeast as represented by landowners A, B or C using multivariate statistical techniques.

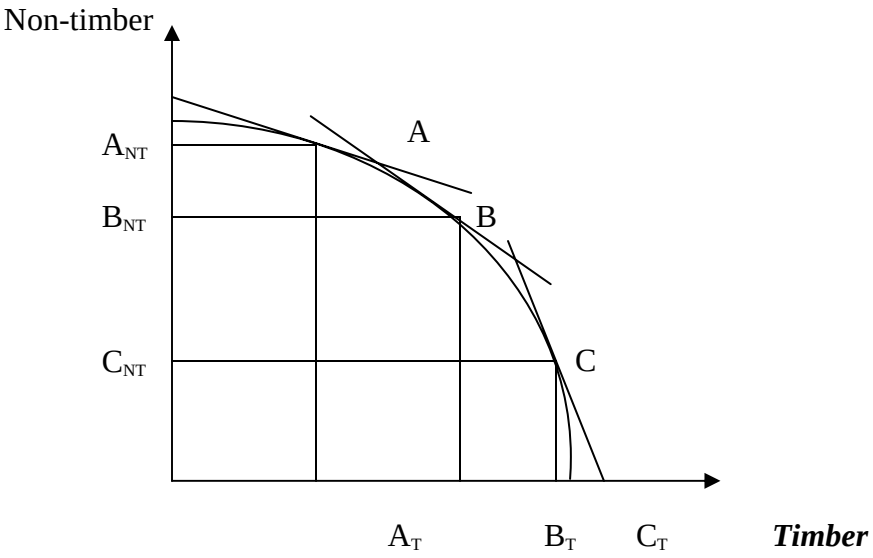

Figure 1 Landowner Behavior Model

DATA AND METHODS

This study is based on an analysis of National Woodland Owner Survey (NWOS) data on the family forest owners in three Southern states: South Carolina, Georgia and Alabama. NWOS is conducted under the Forest Inventory and Analysis (FIA) program of the United States Department of Agriculture (USDA) Forest Service (USFS). The data used in this study was collected during the period 2002-2004.

The NWOS used a self-administered questionnaire distributed to family forest owners by the U.S. Postal Service as the primary survey instrument with telephone interviews conducted sometimes to augment response rates (Butler et al 2005). The questionnaire included 30 questions concerning:

- Forest land characteristics
- Ownership objectives
- Forest use
- Forest management
- Sources of information
- Concerns and issues
- Demographics

The questions in the survey were prepared using a comprehensive questionnaire review process which included expert reviews, pretesting of the survey instrument at several forest land-owner conferences and professional meetings, input from state forestry agencies, expert opinion and review by the clearance office of the USDA forest service [1].

DATA

The total number of private landowners responding to the NWOS during the survey period in South Carolina (SC), Georgia (GA) and Alabama (AL) was 1854 (SC=753, GA=813 and AL=290). Out of these private owner responses, we discarded forest industry (FI) + TIMOs + REITs since we were interested in exploring the diverse set of motivations of the family forest owners. We assumed that the motivations of FIs, TIMOs and REITs were to generate profit from timber management. We also excluded all owners with parcel sizes less than 25 acres due to the economic inefficiencies associated with managing such smaller parcels for timber, and assumed that a rational owner with the aim of maximizing his utility from the forestland had to be motivated mainly by the non-timber amenity values of the forest for a parcel smaller than 25 acres. This resulted in reducing the number of respondents included in the analysis to 1339 from 1854.

STATISTICAL METHODS

This study is related to the identification of family forest landowner groups based on their similar motivations to manage their land and the attached values and interests of these owners in their forestland. The questions that form the basis for identifying the landowner typologies consist of NWOS questions, each emphasizing the perceived importance of various benefits that may be important to the forest owners. All questions were rated by the respondents using an ordinal Likert-type scale of 1-7 where 1 reveals the strongest motive corresponding to 'Very Important' and 7 reveals the weakest motive corresponding to 'Not Important' for owning the land.

Principal Components Analysis (PCA) is the most important statistical routine for dimensional reduction and seeks to transform a larger set of correlated variables into a smaller set of uncorrelated variables or factors without losing much information. PCA with varimax rotation was used to reveal the latent constructs (factors) of forest owner motivations based on the 8 questions mentioned above by utilizing the variance-covariance matrix of responses. Two factors were identified as *economic* and *non-economic* with the former denoting a strong timber interest related to timber harvests and land investment and the latter denoting the non-timber amenity values (biodiversity, aesthetics, recreation) of the forest perceived as the most important reasons for owning the forestland by the landowner. The overall Kaiser-Meyer-Olkin (KMO) [2] measure for factor suitability was 0.72 confirming the factorability of the indicator variables (NWOS questions). The two factors together explained 55% of the variance in the responses to the reasons for owning forestland by the landowners. Reliability analysis was conducted by computing Cronbach's alphas for each factor which ranged from .64 to .72, suggesting internal consistency for each of the factors extracted. Finally, a scores matrix of the order $N \times 2$ where N

(1339) denotes the total number of NWOS respondents with a score on each of the 2 factors was computed by taking each respondents standardized score on each variable, multiplied by the corresponding factor loading of the variable for the given factor, and summing these products. The factor scores describing owner motivations to manage their forestland were used as criterion variables for the cluster analysis.

Cluster Analysis

In order to get meaningful groups of family forest owners based on their motivations for owning and managing their forestland, NWOS data was subjected to clustering analysis using the factor scores on the two factors extracted for each respondent. Since all the clustering routines available through various mathematical software packages are biased towards identifying clusters with certain characteristics, once the data are input it is necessary to identify the algorithm which gives the best interpretable results and then test cluster validation. As a first step to clustering, the SAS procedure CLUSTER explored various hierarchical methods such as single linkage, complete linkage, average linkage, centroid and Ward's method (SAS 2004, p. 955) to determine the best method for clustering the data. The hierarchical clustering method is exploratory in nature and assumes no *a-priori* information about the number of clusters. To get landowner clusters of reasonable proportions and exclude the possibility of producing groups that were too small, Ward's minimum variance method was used. This method is based on least-squares criteria and minimizes the within-cluster sum of squares, thus maximizing the within-cluster homogeneity. The 'agglomerative dendrogram' that provides a visual representation of the step-by-step hierarchical clustering process wherein at each step the two closest clusters are merged into one bigger cluster, was not very useful to evaluate the cluster solution owing to the cumbersome interpretation of a large number of observations (respondents). Based on some of

the most widely used statistics like root-mean-square standard deviations (RMSSTD), semi-partial R-squared (SPR) and R-squared (RS) a three cluster solution was found to be appropriate and supported our initial hypothesis.

Using a non-hierarchical (K-means) method to sort the observations to the nearest centroid through the procedure FASTCLUS [3] in SAS we found similar results compared to the hierarchical method. The results discussed in the next section were obtained by the non-hierarchical clustering routine. 254 incomplete observations (no response on at least one of the 8 questions on reasons for owning forestland from Item 9 of the NWOS) were excluded from the cluster analysis and this resulted in reducing the number of observations to 1085 from 1339.

The three clusters were named *timber* (319 owners or 29.4% of all owners), *non-timber* (233 owners or 21.5% of all owners) and *multiple-objective* (533 owners or 49.1% of all owners). The socio-demographic and forest characteristics of the three types of family forest owners are described in Table 1.

Table 1 Socio-demographic and forest characteristics of family forest owners by cluster

Characteristic	Multiple-objective	Timber	Non-timber
Mean age (yrs)	61.5	64.2	62.2
Men (%)	74.1	66.1	75.9
Mean duration of ownership (yrs)	28.6	31.2	22.4
Income (1000$)	79.4	78.3	71.4
Education	4.2	4.3	3.8
Retired (%)	36.7	42.9	45.5
Mean forest area (ac)*	1345.3(350)[b]	1857.9(333)	384.5(97)[a]
Farm area (ac)*	444.7(160)	411.6(150)	229.7(100)
Management plan (%)	32.1[b]	25.7	10.3[a]
Site preparation (%)	47.8[b]	43.3[b]	12.9[a,c]
Harvest (%)	89.3[b]	86.2[b]	56.6[a,c]
Leased (%)	44.1[b]	52.3	19.7[a]
Inherit (%)	49.3	56.7[b]	27.5[c]

Note: [a], [b] and [c] represent statistically significant separation with the mean for *multiple-objective*, *non-timber* and *timber* group of owners at 0.05 level of significance based on Tukey's studentized range test.

* Values in parentheses refer to the median.

Multivariate analysis of variance (MANOVA) and analysis of variance (ANOVA) were conducted to compare the differences in the means of the profiling variables (Table 1) between the three groups of family forest owners. For MANOVA statistical differences were determined based on Wilk's lambda [4] and this test confirmed the presence of three statistically distinct owner groups based on the landowner responses to emphasize the importance of various reasons for owning their land (question # 9 of the NWOS). Pairwise comparison using Tukey's studentized range test (see Table 1) revealed some statistical differences in forest acreage, whether owners had inherited their land, had performed harvest, leased their land, had a management plan or had done some site preparations in the past across the three owner groups. For example owners belonging to the *timber* and *multiple-objective* clusters tended to own the largest tracts of forest land compared to owners within the *non-timber* cluster who owned the

smallest sized tracts on average possibly reflecting economies of scale associated with larger tracts (Kline et al. 2000). The *timber* cluster owners were also found to have strong linkages to farming and owned on an average 412 acres of farmland. Respondents classified as either *timber* or *multiple-objective* owners had strong financial interest and on an average owned more farmland acres than the *non-timber* group possibly to supplement their timber income through farming. Responses reveal that the *non-timber* cluster owners were the least educated and least wealthy in comparison to the *multiple-objective* cluster owners and the *timber* cluster owners. The majority of the *non-timber* type of owners was retirees though the mean age of all the owners across all ownership types was greater than 60 years, suggesting that the family forests are going to change hands and new owners are going to replace the present surveyed owners shortly. It remains to be seen whether these new owners will have similar motivations as their predecessors or if they will act differently. The longest average tenure of forestland ownership lies with the *timber* cluster owners reflecting that profit motivated owners generally have managed the same forestland for a longer time as compared to owners in other clusters. It also reflects that timber management is a long term decision of the owner belonging to the *timber* cluster when compared to maintaining forestland primarily for non-timber uses by the owners of the *non-timber* cluster. There was a stark contrast in the percent of owners belonging to the *timber* cluster (52.3%) who had leased their land relative to owners within the *non-timber* cluster (19.7%). Further empirical evidence amongst the single ownership objective groups (*timber* and *non-timber*) as expected reflected the difference in the behavior related to timber management with a sharp difference in the percent of owners within each group who had written management plans, did timber harvests in the past and had prepared their land to plant new trees within the last 5 years. The majority of owners classified in the *timber* cluster had inherited their forest

property while the *non-timber* owners were least likely to have inherited their forestland. This coupled with the fact that these owners have the maximum tenure show that *timber* motivated owners have high legacy values relative to the *non-timber* type of ownership. However, owners belonging to the *multiple-objective* ownership class had stronger preferences for both timber and non-timber products relative to the other two owner types.

Cluster validation

While classification procedures using cluster analysis have been applied to family forest owners in a number of studies (Kurtz and Lewis 1981, Marty 1983, Kluender and Walkingstick 2000, Kittredge 2004, Kendra and Hull 2005), none of the studies reported results of any empirical cluster validity test. Based on the 5-step cluster validation technique as suggested by Lattin et al. (2002) we performed a validation test on the NWOS clustering results. According to this technique at the first step the data were randomly split in the ratio 1:1 using the RANSPLIT macro in SAS. The two samples thus formed are referred to as the calibration and the validation samples. At the second step the calibration sample was used for hierarchical cluster analysis and the appropriate number of clusters and their centroids were determined. In the third step the cluster centroid from the second step was used to assign each observation from the validation sample to the nearest centroid using non-hierarchical cluster analysis and the cluster solution was saved. In the fourth step the validation sample was used to perform a similar hierarchical cluster analysis as in the second step and the results were saved in a SAS database. Finally the cluster solutions obtained from the step-3 and step-4 were compared and a confusion matrix (Table 2) depicting the percent of observations in each of the three cluster groups incorrectly classified into another group was created. As can be seen, the percent-misclassification was pretty low and most of the observations that were clustered at both step-3 and 4 of the validation routine also were

found to be in the same cluster group with the percent of correct classification for each of the three types of landowner to be above 95% (see table 2).

Table 2 Confusion matrix for cluster validation

	Multiple-objective	Timber	Non-timber	% Misclassification
Multiple-objective	322	*	8	2.4
Timber	5	181	*	2.7
Non-timber	*	2	189	1.05

* Denotes null or 0 number of observations

CONCLUSION

Our study supports the presence of three groups of family forest owners in the three Southeastern states of AL, GA and SC as discussed in the theoretical model on landowner behavior above and also as reported by Butler (2005) in his study of family forest owners in five southeastern states. It also emphasizes the need to differentiate family forest owners into smaller homogeneous entities. Contradictory to Kendra and Hull's (2005) recent study on new owners in Virginia, the bulk of landowners in our study were found to be motivated strongly by the profit motive either through timber harvests as a source of income generation or choosing forestry as a better land investment option. As reported above, landowners have different objectives and motivations for managing their forestland and identification of those may be critical to developing better informed policy prescriptions. Policies can be targeted towards each owner group according to their needs and interests and thus policy implementation can be made more efficient. For example, timber harvests for owners within the *non-timber* group may be for wildlife habitat or to maintain a healthy forest which is quite different than for economic reasons.

The *multiple-objective* ownership type was found to be the largest group with almost every 1 out of 2 family forest owners in the sample population belonging to this category. These owners derive utility from both economic and non-economic uses of the forest and also

potentially could be the ones targeted by policy makers and resource managers to enhance their production of timber or non-timber outputs since they are not devoted to any single management objective unlike owners in the *timber* and the *non-timber* clusters.

The above work is by no means complete and further analyses of the data by integrating the detailed forest characteristics, which complement the ownership NWOS data, along with linkages to the socio-economic Census data, could produce important information on family forest owner behavior. Also a large number of observations (223) excluded from the analysis due to incomplete responses warrants a closer look to check if there are enough similarities amongst them to be classified as a separate cluster or not. This group could represent owners who are undecided or who don't know the reasons for owning their forestland and are only interested in passive ownership of their forestland. Such owners were identified and termed as *passive* owners in a study of NIPF owners in western Oregon and western Washington by Kline et al. in 2000. Finally, the average age of family forest owners is in the sixties and it remains to be seen if the future change of ownership will be associated with changing owner attitudes and motivations or not. This also suggests the dynamic nature of human behavior and one on which studies need to be updated from time to time.

REFERENCES

Beach, R.H., S.K. Pattanayak, J.C. Yang, B.C. Murray, and R.C. Abt 2005. Econometric studies of non-industrial private forest management: A review and synthesis. Forest Policy and Economics. 7:261-281.

Binkley, C.S. 1981. Timber supply from non-industrial forests: A microeconomic analysis of landowner behavior. Yale University Press, New Haven, CT.

Broderick, S.H., L. Snyder, and B. Tyson 1996. Selling stewardship within the community: A social marketing approach, *in* Proc. of symposium on Nonindustrial private forests: Learning from the past, prospects from the future, M, Baughman, (eds.). Society of American Forestry, Washington D.C.

Butler, B.J. 2005. The timber harvesting behavior of family forest owners. Unpublished Ph.D Dissertation, Oregon State University.

Butler, B.J., E.C. Leatherberry and M.S. Williams 2005.Design, implementation, and analysis methods for the national woodland owner survey. USDA For. Serv. Gen. Tech. Rep. NE-336, Newtown Square, PA. 43 p.

Butler, B.J. and E.C. Leatherberry 2004. America's family forest owners. J. For. 102(7):4-9.

Finley, A.O., Kittredge, D.B., Stevens, T.H., Schweik, C.M. and D.C. Dennis 2006. Interest in cross-boundary cooperation: Identification of distinct types of private forest owners. For. Sci. 52(1):10-22.

Finley, A.O. 2002. Assessing private forest landowners' attitudes towards, and ideas for, cross-boundary cooperation in Western Massachusetts. CFRF Final Report. Department of natural resources conservation. University of Massachusetts, Amherst.

Gramann, J.H., T.D. Marty and W.B. Kurtz 1985. A logistic analysis of the effects of beliefs and past experience on management plans for nonindustrial private forests. J. Environ. Manage. 20:347-356.

Greene, J.L. and K.A. Blatner 1986. Identifying woodland owner characteristics associated with timber management. For. Sci. 32(1):135-146.

Healy, R.G. 1985. Competition for land in the American south. Washington, DC: The Conservation Foundation. 333 p.

Kendra, A. and R.B. Hull 2005. Motivations and behaviors of new forest owners in Virginia. For. Sci. 51(2):142-154.

Kittredge, D.B. 2004. Extension/outreach implications for America's family forest owners. J. For. 102(7):15-18.

Kline, J.D., Alig, R.J. and R.L. Johnson 2000. Fostering the production of nontimber services amongst forest owners with heterogeneous objectives. For. Sci. 46(2):302-311.

Kluender, R.A. and T.L. Walkingstick 2000. Rethinking how nonindustrial landowners view their lands. Southern Journal of Applied Forestry. 24(3):150-158.

Kuuluvainen, J., H. Karpppinen and V. Ovaskainen 1996. Landowner objectives and nonindustrial private timber supply. For. Sci. 42(3):300-309.

Kurtz, W.B., and B.J. Lewis 1981. Decision-making framework for nonindustrial private forest owners: An application in the Missouri Ozarks. J. For. 79:285-288.

Lattin, J., J.D. Carroll and P.E. Green 2002. Analyzing multivariate data. Duxbury Press.

Lee, K.J. 1997. Hedonic estimation of nonindustrial private. forest landowner amenity values. Doctoral dissertation, North Carolina State University, Raleigh, 87p.

Lewis, B.J. 1979. Private non-industrial forest landowners in the Missouri Ozarks: A Q methodological establishment of types. Unpublished M.Sc. thesis, University of Missouri, Columbia. 251p.

Marty, T.D. 1983. An extension of nonindustrial private forest landowner typologies: A Wisconsin study. Unpublished M.Sc. thesis, University of Missouri, Columbia. 230p.

Pattanayak, S.K, B.C. Murray and R.C. Abt 2002. How joint is joint forest production? An econometric analysis of timber supply conditional on endogenous amenity values. Forest Science. 48(3):479-491.

SAS Institute Inc. 2004. *SAS/STAT® 9.1 User's Guide*. Cary, NC: SAS Institute Inc.

Tabachnik, B.G., and L.S. Fidell 2001. Using multivariate statistics (4th Ed.). Needham Heights, MA: Allyn and Bacon.

Vincent, J.R. and C.S. Binkley 1993. Efficient multiple-use forestry may require land-use specialization. Land Economics. 69(4):370-376.

Wicker, G. 2002. Motivation for Private Forest Landowners, *in* Southern forest resource assessment. Wear, D. and J. Greis (eds.). USDA For. Serv. Southern Research Station and Southern Region.

Young, R.A. and M.R. Reichenbach 1987. Factors influencing the timber harvest intentions of nonindustrial private forest owners. For. Sci. 33(2):381-393.

NOTES

---

[1] For a detailed description of the development and implementation of the survey instrument (NWOS) read 'Design, Implementation, and Analysis Methods for the National Woodland Owner Survey' (Butler et al 2005).

[2]KMO is a measure of sampling adequacy and evaluates the appropriateness of the correlation matrix for factoring. KMO values should be greater than 0.6 for a satisfactory factor analysis (Tabachnik & Fidell 2001).

[3] FASTCLUS in SAS uses a nearest centroid sorting iterative method where a set of points known as cluster seeds is selected as the first guess of the mean of the clusters and each observation is assigned to the nearest seed to form temporary clusters, the seeds are then replaced by the seeds of the temporary clusters in an iterative manner until no further changes occur in the clusters (for detail see SAS 2004).

[4] MANOVA results using SAS revealed significant multivariate effect for landowner groups, Wilk's lambda = 0.69, $F(26, 342) = 2.70$; $p < 0.001$.