

Quantifying the distribution of family forest ownership classifications for US federal income tax

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ABSTRACT

Family forest ownerships are classified in federal income tax law as either personal use, investment, or trade or business, and this classification determines the tax rates, deductions, credits, and filing requirements that apply. Tax classification, therefore, has implications for landowners' overall profit potential and the economic sustainability of forest management. However, the relative proportion of family forest owners in each tax classification has never been estimated before, though many studies have looked at the typologies of family forest owners based on their forest management behavior including participation in policy tools in the past. We develop a novel framework for categorizing family forest owners within discrete tax classifications. By leveraging the data from the National Woodland Owner Survey, we estimate the distribution of owners across tax classification and account for the area of forestland covered under various tax provisions. Additionally, we construct logit models to understand demographic and ownership variables associated with the likelihood of landowners belonging to different tax classifications. The estimates based on our categorization criteria to replicate tax classifications indicate that approximately 12% of family forestlands held in parcels of four hectares or more across the country may be owned by business owners, 49% by investment owners, and 39% by personal use owners. Variation in demographic and forest ownership characteristics were noted among landowners estimated to fall under different tax classifications. The findings of the study are expected to have implications for tax policy and sustainable forest management in the country. It will assist policymakers, land managers, and other concerned stakeholders in understanding how changes in tax law affect family forest owners and how they manage their forests. Information about tax classification criteria used in this study can also be helpful for landowner education and extension purposes. The results obtained can assist in mapping natural disasters and connecting them to the deductibility of casualty losses based on landowner's tax classification in the future.

1. Introduction

More than half of U.S. forestlands (179 million of 310 million hectares total) are owned by private forest landowners (Oswalt et al., 2019), who can further be classified as corporate and noncorporate, or "family forest" owners. Family forest ownership encompasses 116 million hectares (38% of U.S. forests) by an estimated 10.6 million families, individuals, trusts, and estates (Oswalt et al., 2019; Butler et al., 2016). Out of the total 116 million hectares of family forestlands, approximately 103 million hectares are held in parcels of four hectares or larger in size by an estimated 3.7 million family forest ownerships. Family

forests supply 42% of annual timber harvest in the country (Butler & Sass 2023), and numerous ecosystem services, including habitat, carbon sequestration, and water quality. To ensure the continued provision of these goods and services, federal, state, and local governments support family forests with programs ranging from informational and educational support to technical assistance, and income and property tax incentives to direct payments (Kilgore et al., 2018; Mehmood & Zhang 2002).

Policies, and their attributes, are one of the key variables used to model family forest owners' management decisions (Beach et al., 2005), and of these, tax incentives play a key role (Greene et al., 2013a; Butler

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et al., 2012). Further, in surveys, family forest owners frequently list taxes as a top concern, with property taxes being the major one. Since federal income taxes apply to income from all sources and the tax rates are higher compared to other taxes, they may also exert a relatively high influence on family forest owners' decision-making process, at least with regards to income-generating activities like production of timber for harvest (Greene et al., 2013a).

For federal income tax purposes, forest activity can be classified as either personal use or hobby ("personal use"), investment, or trade or business ("business"), and this classification determines the tax rates, deductions, credits, and filing requirements that apply to forest landowners (Li et al., 2024; Greene et al., 2013b). In general, the tax classification as business offers a landowner with the greatest opportunity to deduct expenses and losses from income for tax purposes and personal use the least (Wang 2012). Tax classification, therefore, has implications for profit potential and economic sustainability of forest management for landowners.

Despite the importance of tax classification for family forest owners, to the authors' knowledge, no studies have so far estimated the relative proportion of forests or ownership that may fit within different tax classifications in the U.S., or their spatial distribution. Our study develops a novel framework to estimate the numbers of family forest owners in the U.S. by tax classifications. We construct a national-level dataset to capture the proportion of family forest owners potentially within personal use, investment, or business classifications, which we believe can inform future research and the overall policy dialogue on the potential impacts of current and proposed future tax provisions. In a more general sense, this research also adds an additional layer to the existing body of research on the heterogeneity of family forest owners in the U.S. and their motivations and can inform extension programming on various forest management topics. Additionally, we construct logistic regression models with tax classifications as dependent variables and landowner and ownership characteristics as independent variables to understand how such variables may be correlated with classification within different tax classifications in the country.

2. Background

2.1. U.S. federal income tax classification for family forest owners

Although the statutes surrounding the federal income tax (Title 26 of the U.S. Code, also known as the Internal Revenue Code [IRC]) are quite nuanced, as noted above, past literature has identified three or four main tax classifications that can be connected with forest land ownership. Personal use and hobby classifications (which we group together as "personal use" for purposes of this study) are ownerships without a primary objective of generating income ("profit motive"), whereas investment and business classifications are ownerships with a primary profit motive. Thus, personal use owners have primary objectives related to enjoyment, scenery/beauty, recreation (such as camping, hunting, or fishing), etc., rather than to generate income (Greene et al., 2013b; Wang 2012). Investment and business owners manage their forests primarily for income, though they differ in terms of the regularity and continuity of management activities (Greene et al., 2013b; Wang 2012). Compared to business owners, investment owners are less frequently involved in forest management activities, and forest income is not a principal or major source of their household income. Investment owners hold their forests primarily for appreciation or occasional timber sales and have minimal involvement in day-to-day forest management activities and may rely on third-party managers or consultants. Investment owners may hold the land passively while waiting for timber to appreciate. Business owners carry out substantial management activities on a regular basis (Greene et al., 2013b). The two key characteristics of business ownership are regularity of activities and transactions and the production of income. Business owners are more involved in regular day-to-day management of their forests and spend more time and effort

managing the timber operation compared to investment owners (Greene et al., 2013b). A landowner's involvement in the business may be material participation or a passive activity. Material participation implies regular, continuous, and substantial activity and results in more favorable tax deductions. Losses from passive activities on the other hand are only deductible against passive income (Greene et al., 2013b).

Factors used in determining the tax classification include documentation of profit motive (e.g., management plan indicating objective of commercial timber production) as well as indicators such as the quality of record keeping by landowners, the level of income obtained from their forests, success at generating profit, the level of knowledge regarding forest management activities, time and effort expended in carrying on forest management activities, seeking expert advice for managing the forests, and carrying out forest management activities with the expectation that forestlands and forests may appreciate in value in the future though not generating profit yet (26 Code of Federal Regulations [CFR] 1.183–2) (Code of Federal Regulations, 2024).

Table 1 outlines some of the key federal income tax provisions relevant for forest landowners in the US and list how these may or may not vary depending upon landowners' tax classification.

2.2. Past research on family forest owners and their categorization

Given the significance of family forest ownership in providing numerous ecosystem services, including forest products to society, several studies have looked at the management behavior of family forest owners including their participation in policy tools and the efficacy of such tools in the past (Frey 2023; Kilgore et al., 2018; Kilgore et al., 2015; Greene et al., 2014; Joshi & Arano 2009, Potter-Witter 2005; Kluender et al., 1999). Others have conducted systematic reviews of published literature to highlight the key factors influencing the forest management decisions of family forest owners (Floress et al., 2019; Silver et al., 2015). These past studies note landowner characteristics such as age and education level, knowledge about incentive programs, participation in extension activities, ownership objectives, parcel size, presence of forest management plan, and landowners' distance from their residence to be the most commonly found variables that are significant at predicting forest management behavior of family forest owners (Floress et al., 2019; Silver et al., 2015).

Past studies also acknowledge the heterogeneity of forest ownership values and attitudes as well as preferences regarding government incentive programs among family forest owners (Khanal et al., 2017; Gc & Mehmood 2010; Majumdar et al., 2008; Finley & Kittredge 2006). A common method adopted by many studies to understand diverse family forest ownership groups in the country is to cluster or segment landowners based upon their ownership objective into distinct categories that are heterogeneous between groups and homogenous within groups (Finley & Kittredge 2006; Salmon et al., 2006). Khanal and others (2017) provide an account of such studies conducted in the past, including the typology of family forest owners identified by these studies. Common family forest ownership groups/clusters identified by past studies include some form of timber producers/managers, recreationists, multi-objective owners, and naturalists or passive owners (Kuipers et al., 2013; Joshi & Mehmood 2011; Salmon et al., 2006; Kline et al., 2000). More recently, Sass and others (2023) found that family forest ownership in the country is changing in terms of demographic characteristics and reason for owning forestland, noting level of engagement in forest management decreasing for traditional wood products and increasing for amenity values. To our knowledge, no studies have looked at family forest owners from a tax classification perspective, though many highlight the importance of taxes in the economic sustainability of forest management for family forest owners (Greene et al., 2013a; Butler et al., 2012).

Table 1

Summary of federal income tax provisions affecting family forest owners in the United States, and how tax classification does or does not affect applicability.

Tax provision	Description	Applicability based on tax classification
Capital gains	Income obtained from the sale of standing timber held over 1 year generally qualifies for lower long-term capital gain tax rate.	Applicable to all three landowner tax classifications. However, business must make a special election under IRC 631.
Timber depletion deduction	Landowners may deduct a portion of the capitalized cost from their gross harvested income to arrive at a net profit that is taxed. All or part of management expenses may be deducted in the year that the expense occurred.	Applicable to all three landowner tax classifications.
Annual deduction of management expenses		Not allowed for personal use. Suspended through 2025, and otherwise limited for investment owners. Generally allowed for business owners.
Bonus depreciation and section 179 provision	The cost of certain items with a useful life greater than one year can be recovered more quickly than allowed under normal depreciation deductions.	Applicable to investment and business owners.
*Deduction for casualty losses	The lesser of adjusted basis or fair market value for timber lost due to sudden, unusual, and unexpected event can be recovered.	Generally applicable to business and investment owners. Personal use owners can deduct casualty loss only if the loss is attributable to a federally declared disaster.
Deduction for theft or condemnation	Adjusted basis of the timber lost due to theft or condemnation may be recovered.	Applicable to business and investment owners. Personal use owners can deduct theft loss only if the loss is attributable to a federally declared disaster.
Deduction for noncasualty losses	Timber basis lost due to unusual, and unexpected event, which is not sudden, can be recovered.	Applicable to business and investment owners.
Reforestation tax incentives	Landowners may deduct up to \$10,000 of reforestation expenditure per year per qualifying timber property in the year it occurred and amortize the remaining amount over 84 months.	Applicable to business and investment owners.
Exclusion of qualifying conservation cost-share payments	All or a part of the payment received from approved conservation government cost share may be excluded from gross income.	Applicable to all tax classifications.
Net investment income tax	Investment income for taxpayers with modified adjusted gross income over a stated threshold is subject to additional 3.8% tax.	Applicable to investment and passive business owners. Business owners who materially participate in their business are not subject to this tax.
Qualified business income deduction	Eligible taxpayers to deduct up to 20% of their qualifying business income.	Applicable only to business owners.

* Special Note: A bill under consideration in the 118th Congress, the “Disaster Reforestation Act” (H.R. 655, S. 217), would give business owners the additional benefit of being able to deduct the greater of basis or fair market value, while investment owners would be able only to deduct the lesser.

3. Methods

3.1. Data

To categorize family forest owners into groups representing three

discrete tax classifications, we used the most recent (2017–2018) data from the National Woodland Owner Survey (NWOS), implemented by the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) program (Butler et al., 2021a). The raw survey data was obtained following the FIA program’s protocol needed for accessing such information.

Following Butler et al. (2021a), we limited the data to all NWOS respondents, excluding interior Alaska, who indicated owning at least ten acres (four hectares) of wooded land in the 2018 survey. Interior Alaska has very limited data in the survey. Those owning smaller parcels of wooded land may find it challenging to manage for profit using traditional forestry practices, and thus would almost all fall into the personal use classification. Further, ten acres (four hectares) is the minimum area in many states to qualify for forestry assistance programs (Butler et al., 2021a). Applying these filters reduced the dataset to 8,639 records, which were used for the analysis. It should be noted that approximately 67% of family forest owners (who own 7% of the total forest area owned by family forest ownership in the country) have forest parcels that are less than ten acres (four hectares) in size (National woodland owner survey dashboard, 2024). Population-level estimates from the survey data were obtained using the methods listed in Butler and Caputo (2021).

3.2. Criteria for determining tax classification

Since NWOS does not ask landowners directly about their tax classification status, we identified a list of variables based on the survey that could be used as proxy criteria. The list of variables selected in this study should not be mistaken for the definitive criteria used by the Internal Revenue Service (IRS) for determining the tax classification of family forest owners under federal income tax law. This determination would consider all the unique facts and circumstances surrounding an individual taxpayer and their forest activity, which cannot be precisely replicated through NWOS. Rather, our categorization should be viewed as a reasonable grouping mechanism developed by the authors based on the review of relevant literature (Li et al., 2024; Greene et al., 2013b; Wang 2012), court cases (Louis W. & Maud Hill Family Foundation Vs. United States, Holmes Vs. Commissioner), and expert consultation (personal communication, Andrew Bosserman, J.D., C.P.A.) outlining the general criteria.

To create the three landowner categories representing approximations of the three tax classifications (personal use, investment, business), we used several NWOS variables and created new variables based on those, which are described in Appendix 1, with a summary of important variables in Table 2. The process included two basic steps, as shown in Fig. 1, following the steps generally used by the IRS and tax courts: first, determining if the landowner has a “profit motive,” and second, determining if the management and/or income was considerable enough to be considered a business. Landowners lacking profit motive are considered personal use owners, whereas those with profit motive but lacking considerable income or frequency of management are investment owners, and those with both profit motive and considerable income or frequency of management are business owners. Briefly, landowners were considered personal use (no profit motive) if they did not indicate timber production or land investment as important reasons for owning their wooded land, lacked nontimber income from their wooded land, had conducted zero of thirteen selected management or income-related activities, and lacked a written forest management plan for their wooded land. We believe this provides multiple broad pathways, reasonably aligning with the tax code and court cases, for landowners to be categorized with a profit motive. Further, these indicators rely on self-reporting of objectives and activities, whereas the IRS or courts would rely on documented evidence. Thus, while any individual’s classification is dependent on specific facts and circumstances that are not replicable in a survey, we believe this approach offers a conservative estimate in the sense of an upper bound on the number of landowners

Table 2

Key variables used in creating landowner categories representing approximations of tax classifications. See also Fig. 1 and Appendix 1.

Variable	Description
AC_WOOD	How many acres of wooded land do you currently own in [State]?
OBJ_TIM	How important [is] the following as [a reason] for why you currently own your wooded land in [State]?... For timber products, such as logs or pulpwood
OBJ_INV	How important [is] the following as [a reason] for why you currently own your wooded land in [State]?... For land investment
LEASE	Have you ever leased or collected money (other than from logging) for allowing people to use your wooded land in [State]?
NTPF_WHY_SALE	Have nontimber forest products been collected from any of your wooded land in [State] for sale?
CARBON	Is any of your wooded land in [State] currently enrolled in one of these carbon capture programs or markets?
MAN_PLAN	Do you have a written management or stewardship plan for any of your wooded land in [State]?
CUT	Have any trees been cut or removed from your wooded land in [State] since you have owned it?
INC_WOOD	On average, what percentage of your household's annual income is derived from the wooded land that you own?
TIMBER_FOCUS	Production of timber products is considered important or very important (Obtained using OBJ_TIM)
LAND_INVESTMENT_FOCUS	Land investment is considered important or very important (Obtained using OBJ_INV)
NONTIMBER_INCOME	Obtained income from leasing other than for logging, enrolling in carbon program, or collecting and selling nontimber forest products (Obtained using LEASE, NTPF_WHY_SALE, and CARBON)
ACT_COUNT	Total count of forest management or income-oriented activities in which the landowner has engaged, out of thirteen selected activities in NWOS survey.

that may fit within the profit motive classification, and the lower bound that could be classified as personal use. Sources of nontimber income considered in our analysis include income obtained from the collection and sale of nontimber forest products, leasing wooded land for activities other than logging, and enrolling woodland in a carbon program. Of the remaining profit-motivated owners, business owners were those who either (1) had a written forest management plan and had conducted at least five of thirteen selected management or income-related activities, or (2) had a written forest management plan, had conducted timber harvest at least once since owning the wooded land, and income from the wooded land was at least 20% of their annual household income. Twenty percent was an arbitrarily selected threshold, but it represents a considerable contribution to household income and may indicate that a landowner is dependent on the income from their forests. If a landowner is profit-motivated and does not qualify as a business owner, then they would fall into the classification of investment owner. After estimating the proportion of family forest owners belonging to different tax classifications, descriptive statistics were estimated to compare demographic and ownership variables across tax classifications. In addition to the national level estimates, the proportion of family forest owners belonging to different tax classifications was estimated at regional (North, South, Rocky Mountain, and Pacific Coast) and four subregional levels (North Central, Northeast, South Central, and Southeast) (Fig. 2) since the distribution of family forest ownership is not even across the country (Fig. 3).

An important limitation of the study that should be considered when interpreting the results is that the proportion of different tax classifications estimated in the study are based on the simplifying assumptions made by the authors, through the review of published literature, law, and expert consultation to come up with tax categorization criteria. These selected criteria cannot mimic the criteria used by the IRS for determining tax classification of family forest owners, which are more

nuanced as the IRS considers unique facts and circumstances surrounding each individual taxpayer, and so should not be considered the same.

3.3. Model estimation for understanding landowner and ownership characteristics associated with their likelihood of belonging to different tax classifications

To understand the landowner and ownership characteristics that correlate with tax classifications, we constructed a multinomial logit model with our identified estimated categories based on tax classifications (personal use, investment, and business) as the dependent variable and a suite of ownership and landowner characteristics as independent variables. The selected independent variables included demographic characteristics of landowners (age, gender, and education level), ownership characteristics (size of forest area owned, distance of landowner's residence from the forest, and length of forest ownership), and motivation for owning the forestland (wildlife management, and enjoying beauty or scenery). Since the instructions in the National Woodland Owner Survey states that the landowner who makes most of the decisions about their wooded land should be the person filling out the questionnaire, we assume that the responses (including demographic variables) are representative of the person most involved in decision-making process. However, we do acknowledge that this may not always be true as some respondents may not follow the instructions precisely, or decision-making may be a collective process for them without a clear single leader.

Table 3 provides an explanation of the variables used in the model. The independent variables were selected based on the review of past literature, which frequently cites demographic and ownership characteristics as well as landowners' motivation for forest ownership to influence their forest management decisions (Floress et al., 2019; Silver et al., 2015). Since the outcome variable has three discrete levels (three tax classifications), multinomial logistic regression is applicable in our case as it generalizes logistic regression to situations with more than two levels of dependent variable. Multinomial logistic regression determines the log odds of a landowner belonging to one tax classification versus another while other variables are held constant. In this type of analysis, one category of dependent variable is chosen as the reference category (personal use ownership in our case), against which other dependent variable categories are compared. Additionally, to compare the landowners belonging to categories representing investment versus business tax classifications, we constructed a binary logistic regression model with categories representing investment and business tax classifications as the dependent variable (Coded 0 for investment and 1 for business tax classification) and the same suite of landowner and ownership characteristics as used in the multinomial logit model as the independent variables. Statistical tests were performed in SPSS version 28, and a 5 percent alpha level was chosen as a cut-off criterion.

4. Results

4.1. Estimated distribution of family forest ownership under different tax classifications

In terms of tax classification, approximately 12% of family forest area in the country (i.e., 12.7 million hectares, standard error [SE] = 0.5 million hectares) was estimated as business, 49% (49.9 million hectares, SE = 0.8 million hectares) as investment, and the remaining 39% (39.9 million hectares, SE = 0.8 million hectares) as personal use. Collectively, the total family forest area estimated as business was owned by 106 thousand family forest ownerships (SE = 9 thousand), those estimated as an investment were owned by 1,369 thousand ownerships (SE = 53 thousand), and personal use was owned by 2,220 thousand ownerships (SE = 58 thousand) nationally. In terms of spatial distribution, about 70% of the total family forest area estimated as business was in the

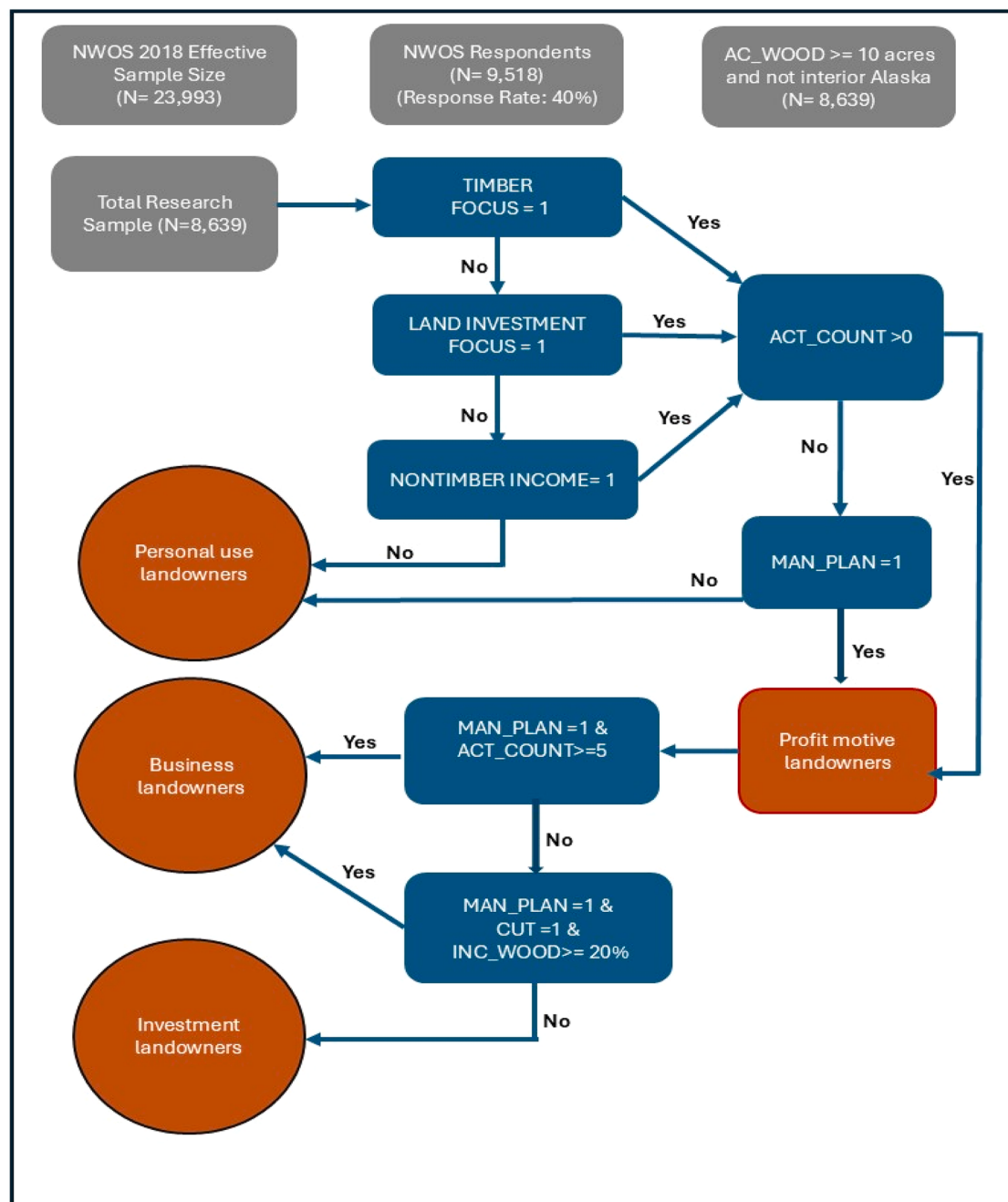


Fig. 1. Flowchart depicting the process involved in categorizing family forest owners into discrete tax classifications for federal income tax using 2018 National Woodland Owner Survey data.

South, followed by the North (19%), the Pacific Coast (6%), and the Rocky Mountain region (5%), respectively. South also led the other regions in terms of total forest area estimated under investment and personal use classifications. Approximately 61% of the total family forest area estimated as investment was in the South, followed by 26% in the North, 8% in the Rocky Mountain region, and 5% in the Pacific Coast, respectively. In terms of personal use classification, 44% of the total family forest area estimated as personal use was in the South, 43% in the North, 9% in the Rocky Mountain region, and 4% in the Pacific Coast. The distribution of family forest area estimated under three tax classifications and percentage breakdown in terms of total forest area owned at national, regional, and subregional levels are presented in Fig. 4.

Approximately 8.9 (SE = 0.5) million hectares of family forest area in the South, 2.5 (SE = 0.2) million hectares in the North, and 0.7 (SE =

0.1) million hectares in the Pacific Coast and the Rocky Mountain region were estimated as business ownership. These are, respectively, 16% of the total family forest area in the South and the Pacific Coast, 8% in the Rocky Mountain region, and 7% in the North (Fig. 4). At the subregion level, 1.3 (SE = 0.1) and 1.2 (SE = 0.1) million hectares of forest area in the Northeast and the North Central, and 5.2 (SE = 0.4) and 3.7 (SE = 0.3) million hectares in the South Central and Southeast were estimated as business ownership.

About 30.3 (SE = 0.7) million hectares in the South, 13.1 (SE = 0.4) million hectares in the North, 4.2 (SE = 0.3) million hectares in the Rocky Mountain region, and 2.3 (SE = 0.2) million hectares in the Pacific Coast were estimated as investment ownership. These are, respectively, 53% of the family forest area in the South, 40% in the North, 51% in the Pacific Coast, and 50% in the Rocky Mountain region. In terms of

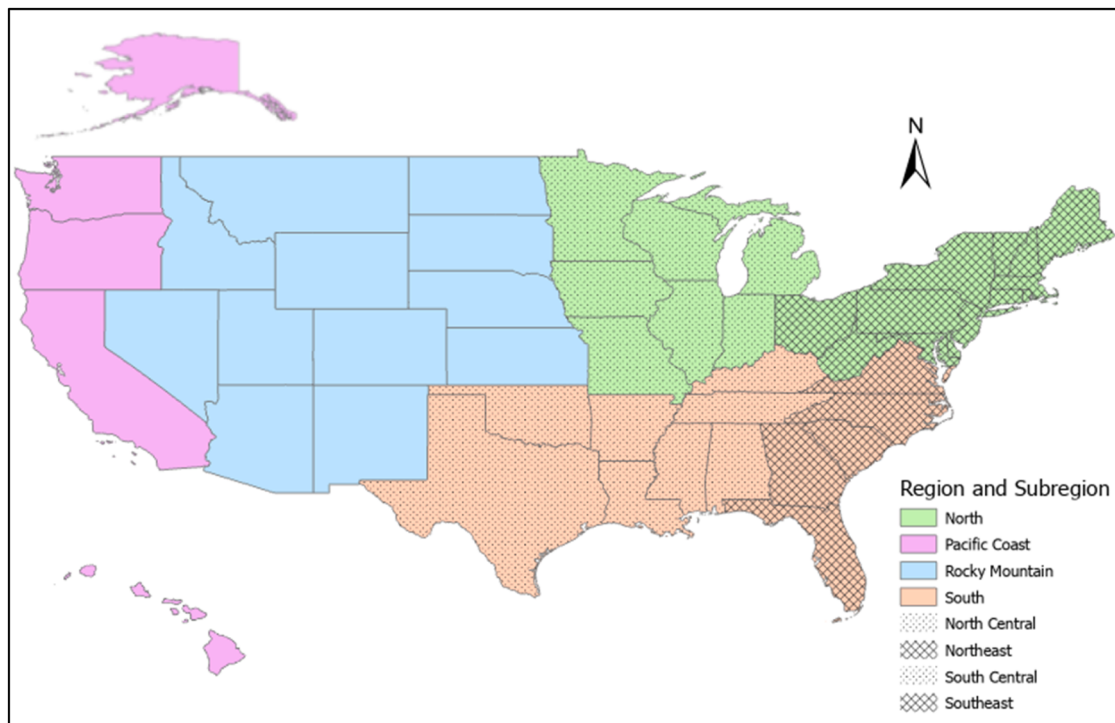


Fig. 2. Map of US showing resource planning act assessment regions and subregions (Adapted from: [Oswalt et al., 2019](#)).

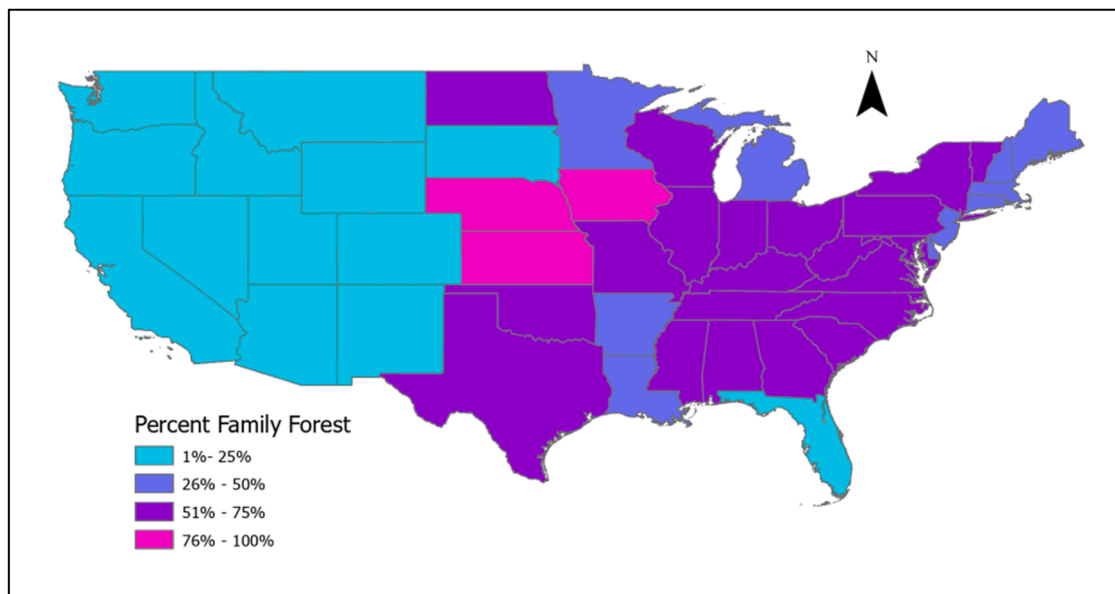


Fig. 3. Map of US showing distribution of family forest ownership as a percentage of total forest area in the state (Source: [Sass et al., 2020](#)).

subregions, approximately 7.3 (SE = 0.3) and 5.8 (SE = 0.3) million hectares of family forest area in the North Central and Northeast and 21.9 (SE = 0.6) and 8.4 (SE = 0.3) million hectares in the South Central and Southeast were estimated as investment ownerships.

Personal use owners were estimated to own approximately 17.7 (SE = 0.6) million hectares of family forest area in the South, 17.3 (SE = 0.4) million hectares in the North, 3.4 (SE = 0.2) million hectares in the Rocky Mountain region, and 1.5 (SE = 0.2) million hectares in the Pacific Coast. This is 53% of family forest area in the North, 42% in the Rocky Mountain region, 33% in the Pacific Coast, and 31% in the South. In terms of subregion, the South Central had the greatest area that qualified as personal use classification (13.1 million hectares, SE = 0.6

million hectares), followed by the North Central (10.4 million hectares, SE = 0.3 million hectares), the Northeast (6.9 million hectares, SE = 0.3 million hectares) and the Southeast (4.6 million hectares, SE = 0.3 million hectares) respectively. The estimated number of family forest ownership under different tax classifications and their percentage breakdown in terms of total family forest ownership at national, regional and subregional levels are presented in [Fig. 5](#).

4.2. Demographic and ownership characteristics of family forest owners estimated as business, investment, and personal use tax classifications

Many similarities and some differences in demographic

Table 3

Name and definition of variables used in logit models for estimating family forest owners' likelihood of belonging to different tax classifications.

Variable	Definition
AGE	Age of family forest owner (Continuous variable)
GENDER	Dummy variable: "1" if a landowner is male, "0" if female
EDUCATION	Dummy variable: "1" if a landowner has bachelor's or higher level of education, "0" otherwise.
TENURE	Duration of forest ownership in years (Continuous variable)
FOREST AREA	Natural log of size of forest holding (Continuous variable)
RESIDENT	Dummy variable: "1" if a landowner's primary residence is within one mile of their forested parcel, "0" otherwise.
WILDLIFE	Dummy variable: "1" if a landowner indicates to protect or improve wildlife habitat as an important or very important reason for forest ownership, "0" otherwise.
BEAUTY	Dummy variable: "1" if a landowner indicates enjoying beauty or scenery as important or very important reason for forest ownership, "0" otherwise.

characteristics were noted among family forest owners belonging to different tax classifications. The majority of the survey respondents in all three tax classifications (74% and more) were male with an average age of 65 years. Compared to business owners, a slightly higher percentage of respondents categorized by our procedure as investment and personal use were found to be female (26% in personal use versus 22% in

investment and 15% in business). In terms of education level, approximately 65% of respondents categorized by our procedure as business had a bachelor's degree or higher level of education, while 46% of investment, and 39% of personal use owners had the same level of education.

About 58% of respondents categorized by our procedure as business, 62% of investment, and 63% of personal use had a primary residence within a mile of their forested parcel, meaning that they were resident landowners. Family forest owners belonging to all three tax classifications had owned their forested parcels for an average of over 20 years (25 years for business and personal use owners and 24 years for investment owners). Considerable variation was noted in terms of forest ownership size across tax classifications. The mean forest ownership size of those categorized by our procedure as business was found to be 120 hectares (SE = 8.0 hectares) (median: 40 hectares, SE = 5.4 hectares), while that of investment was 36 hectares (SE = 1.1 hectares) (median: 15 hectares, SE = 1.0 hectares) and personal use was 18 hectares (SE = 0.3 hectares) (median: 9 hectares, SE = 0.5 hectares). Ninety percent of those categorized by our procedure as business, 76 percent of investment, and 63% of personal use indicated that they harvested timber at least once since owning their forestland. Most family forest owners belonging to all three tax classifications (over 80%) rated enjoying beauty or scenery as an important or very important reason for owning their forestland. Approximately 86% of respondents categorized by our

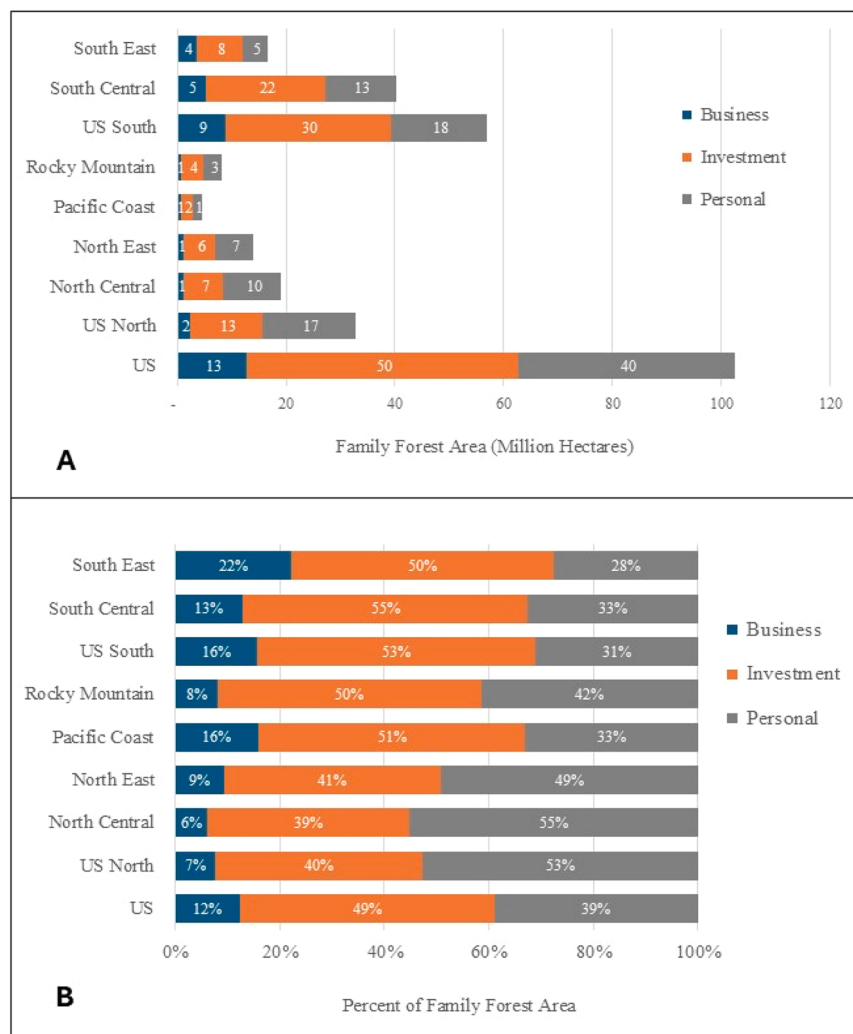


Fig. 4. (A) Hectares of family forestland estimated under three tax classifications and (B) percentage of total family forest area under these classifications at national, regional and subregional levels for forestlands held in parcels of four hectares or larger.

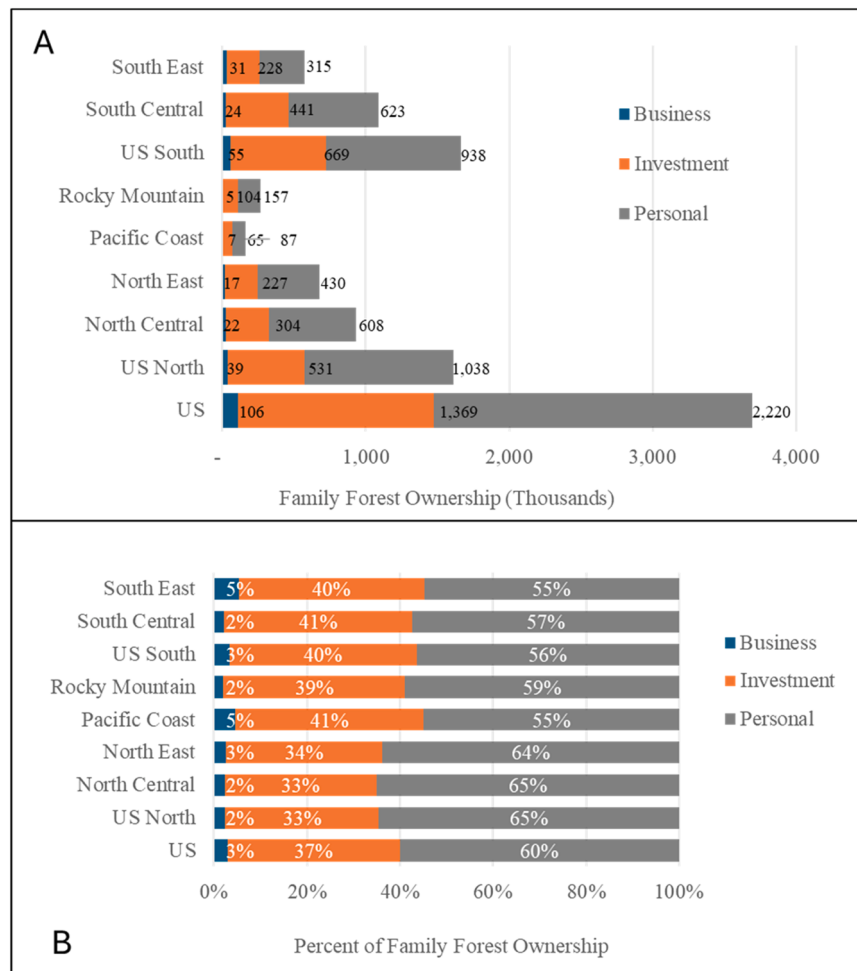


Fig. 5. (A) Estimated number of family forest ownerships under three tax classifications and (B) percentage of total family forest ownerships under these classifications at national, regional and subregional levels for forestlands held in parcels of four hectares or larger.

procedure as business, 77% of investment, and 76% of personal use also rated protecting and improving wildlife habitat as an important or very important reason for owning their forests.

4.3. Results from multinomial logistic regression model

The log-likelihood ratio of the multinomial logit model estimated to understand the factors associated with the likelihood of family forest ownership being categorized by our procedure aligning with different tax classifications was significant at a 5% alpha level (Chi-square = 1734.10, P value < 0.001). The Pearson Chi-Square and deviance goodness-of-fit tests were both not significant, thus suggesting adequate model fit. The results of the logit model are presented in Table 4.

For investment, a variable representing forest landowner's demographic characteristic (i.e., EDUCATION) was significant and had a positive coefficient, meaning that landowners with a bachelor's or higher level of education are more likely to be categorized as investment with our procedure compared to personal use. The odds of a landowner falling under investment were 1.14 times higher than their odds of falling under personal use if they had a bachelor's or a higher level of education. Similarly, a variable representing the landowner's forest ownership characteristic (i.e., FOREST AREA) and a variable representing their motivation for owning the forest land (WILDLIFE) were significant for investment. Both significant variables had a positive coefficient, meaning that family forest owners with larger forest areas and those who indicate protecting and improving wildlife habitat as an important reason for owning their forests are more likely to be

Table 4

Multinomial logit estimates of family forest owners' likelihood of belonging to different tax classifications for federal income tax purposes. The reference level for the dependent tax classification variable is personal use.

Tax Classification	Variables	Coefficient	Std. Error	P value	Exp (B)
Investment	Intercept	-2.041	0.187	0.000	
	AGE	-0.003	0.002	0.267	0.997
	GENDER	0.002	0.059	0.975	1.002
	EDUCATION	0.133	0.049	0.007*	1.142
	TENURE	0.000	0.002	0.834	1.000
	FOREST AREA	0.464	0.019	0.000*	1.590
	RESIDENT	0.038	0.050	0.454	1.038
	WILDLIFE	0.189	0.065	0.003*	1.208
	BEAUTY	0.007	0.067	0.921	1.007
	Intercept	-6.277	0.323	0.000	
Business	AGE	-0.014	0.004	0.000*	0.986
	GENDER	0.251	0.108	0.020*	1.286
	EDUCATION	0.784	0.086	0.000*	2.191
	TENURE	0.008	0.003	0.006*	1.008
	FOREST AREA	0.938	0.029	0.000*	2.555
	RESIDENT	0.129	0.083	0.122	1.138
	WILDLIFE	0.331	0.112	0.003*	1.392
	BEAUTY	0.009	0.110	0.935	1.009

* Significant at alpha of 0.05

categorized as investment with our procedure compared to personal use. The odds ratio for FOREST AREA was 1.59, and for WILDLIFE was 1.21.

The same three variables that were significant for investment (EDUCATION, FOREST AREA, and WILDLIFE) were also significant and had similar signs for coefficients in the case of business. This suggests that landowners with a bachelor's or higher level of education, those owning larger forest areas, and those who value improving wildlife habitat as an important reason for owning their forests were more likely to be business owners compared to personal use owners. The odds ratio for EDUCATION was 2.19, for FOREST AREA was 2.56, and for WILDLIFE was 1.39 in the case of business.

Additionally, two other variables representing landowner's demographic characteristics (AGE and GENDER) and a variable representing their ownership characteristic (TENURE) were significant in business. GENDER and TENURE had positive coefficients, meaning that male landowners and those who have owned their forests for a longer duration are more likely to be categorized as business with our procedure compared to female landowners and those who have owned their forests for a shorter duration. The odds ratio for GENDER was 1.29, and that for TENURE was 1.01. AGE had a negative coefficient, meaning that the older the landowner, the less likely they are to be categorized as business with our procedure and more likely to be categorized as personal use. The odds ratio for AGE was noted to be 0.98.

4.4. Results from binary logistic regression model

The binary logistic regression model estimated to understand landowner and ownership characteristics associated with the likelihood of family forest owners being categorized as business versus investment with our procedure was significant at a 5% alpha level (Chi-square = 522.187, p -value = 0.000). Two variables representing ownership characteristics (FOREST AREA and TENURE) and three variables representing demographic characteristics (AGE, EDUCATION, and GENDER) were significant in the model (Table 5). All the significant variables except AGE had positive coefficients, suggesting that male landowners with higher levels of education (those owning a bachelor's or higher level of education), landowners owning larger forest areas, and those who have owned their forests for a longer duration are more likely to be categorized as business with our procedure compared to investment. AGE had a negative coefficient, suggesting that older landowners are less likely to be business than investment. The odds ratio for FOREST AREA was noted to be 1.63, TENURE 1.01, EDUCATION 1.93, GENDER 1.32, and AGE 0.99. None of the variables representing motivation for forest ownership (WILDLIFE or BEAUTY) were significant in the model.

5. Discussion and conclusions

With the passing of the Revenue Act of 1913, the federal income tax law in the U.S. was reinstated, introducing a progressive tax rate structure in the country. Revenues generated from forest management activities are subject to these federal income tax laws, which can

significantly impact the financial aspects of forest management for landowners (Greene et al., 2014). The Internal Revenue Code offers options that reduce taxes for landowners who elect to do so. The tax classification of a forest landowner is a critical factor that influences the applicable tax rates and available deductions. A better understanding of these classifications can help landowners optimize their tax benefits, ensure accurate tax filing, and maintain regulatory compliance. Moreover, estimating the forestland area under different tax classifications and their spatial distribution can assist policymakers and other stakeholders in understanding the effects of current tax policies on family forest owners nationwide. This insight can also aid in assessing the potential impact of future tax policy changes, facilitating informed decision-making to ensure appropriate tax treatment and promote sustainable forest management practices. For example, a bill under consideration in the 118th Congress, the "Disaster Reforestation Act" (H. R. 655, S. 217), would alter casualty loss provisions to give forest business owners the ability to deduct the greater of basis or fair market value, leaving investment and personal use owners still only to deduct the lesser, and personal use only in cases where the casualty was due to a federally-declared disaster. Our analysis suggested that this change would increase deductions for potentially only about 3% of family forest owners that control 12% of family forest land, leaving out the remaining 97% of family forest owners who own 88% of forestlands held in parcels of 4 hectares or more.

In this study, we used NWOS data to categorize family forest landowners into three distinct tax classifications for federal income tax purposes: personal use, investment, and business. Additionally, we used logistic regression models to understand demographic and ownership characteristics that are correlated with the likelihood of landowners belonging to different tax classifications. Our findings indicate that approximately 39% of forestlands held in parcels of four hectares or more across the country may be owned by personal use owners according to our procedure to estimate these classifications, who primarily value their forests for non-profit reasons, such as personal enjoyment or recreation. These owners tend to have smaller forest parcels and are less likely to be engaged in active forest management. Due to the diseconomies of scale, owning smaller forest parcels may disadvantage this group in terms of actively managing their forests. Moreover, since they are less involved in active forest management, the inability to deduct annual management expenses may be less of a concern for personal use owners. However, if forests under personal use ownership suffer losses from natural disasters (such as wind, fire, ice, flooding) or other disturbances such as insects, disease, vegetative competition, and animals, the deductibility of losses applicable to them are either non-existent or significantly limited (if applicable) compared to what investment or business owners can claim. About 53% of family forest area in the U.S. North, 42% in the Rocky Mountain region, 33% in the Pacific Coast, and 31% in the South were estimated according to our criteria to fall under personal use ownership. Outreach and educational programs tailored to the needs of personal use owners could emphasize the advantages of transitioning to a more active forest management approach, particularly considering potential financial incentives and tax benefits. Emphasizing the forest health as well as aesthetic benefits associated with active forest management may resonate with this group. Additionally, resources focused on addressing the challenges posed by smaller parcel sizes and associated economies of scale could assist personal use owners intending to transition to more active forest management.

Collectively, about 61% of family forestlands in the country owned by 40% of family forest owners (held in parcels of 4 hectares or more) are estimated to be owned by profit-motivated family forest owners (those identified as investment and business). Compared to personal use owners, these profit-motivated landowners tend to have higher levels of education and larger forest areas on average. Larger forest ownership size likely puts profit-motivated landowners at an advantage in securing the workforce and conducting forest management activities owing to the economies of scale. Besides, profit-motivated owners, according to our

Table 5

Binary logit estimates of family forest owners' likelihood of belonging to business versus investment tax classifications for federal income tax purposes.

Variables	Coefficient	Std. Error	P value	Exp(B)
Intercept	-4.359	0.311	0.000	0.013
AGE	-0.011	0.004	0.003*	0.989
GENDER	0.275	0.105	0.009*	1.316
EDUCATION	0.657	0.083	0.000*	1.929
RESIDENT	0.118	0.080	0.143	1.125
FOREST AREA	0.486	0.027	0.000*	1.626
TENURE	0.008	0.003	0.007*	1.008
WILDLIFE	0.140	0.107	0.190	1.151
BEAUTY	0.037	0.105	0.720	1.038

* Significant at alpha of 0.05

study, more frequently mentioned protecting and improving wildlife habitat as an important reason for forest ownership compared to personal use owners. Their desire to improve wildlife habitats could also be one of the reasons that motivate profit-oriented landowners to actively manage their forests. Of the profit-motivated investment and business owners, a higher proportion of business owners are male with higher levels of education and own larger forest areas on average. Past studies have frequently noted forest holding size to be one of the key determinants of family forest owners' forest management decisions (Stordal et al., 2007; Vokoun et al., 2006). Using a segmented regression approach, Butler and others (2021b) noted forest holding size to be significantly related to 16 forest management activities and attributes of family forest owners in the country. Likewise, Hatcher and others (2016) found forest ownership size to be one of the key determinants of family forest owners' use of federal income tax provisions. Our results are in line with these findings.

Relatively lower representation of female ownership in business tax classifications and higher representation in personal use tax classification suggests that female family forest owners may be less profit-oriented and less engaged in active forest management compared to their male counterparts. These findings are consistent with those noted by Berget and Dwivedi (2024) and Butler et al. (2017). Given the increasing proportion of family forest areas owned by female forest owners across the country, education of female forest owners about different forest management activities as well as financial and business aspects of forestry may reduce these differences. A potentially useful line of new research would quantify the efficacy of targeted extension materials, workshops, seminars, or peer learning networks that enable female forest owners to come together, connect with each other, express their concerns, share experiences, and learn from the experts.

Of the estimated family forest area categorized by our procedure as business nationwide, the majority (70%) is in the U.S. South, followed by 19% in the North. Likewise, 61% of family forestlands identified as potential investment are in the South, followed by 26% in the North. Profit-motivated landowners are already involved in active forest management compared to personal use owners. Further, although personal use owners are not profit-motivated and are less active forest managers by definition, a large majority (63%) had harvested timber on their land at least once since owning it. Thus, despite being more motivated by amenity values, personal use owners as a group are not averse to generating financial benefits. Conversely, despite belonging to investment or business tax classification, over 80% of landowners nationwide indicated enjoying beauty or scenery, and over 75% indicated protecting or improving wildlife habitat as important reasons for owning their forests. Additionally, over half of the landowners belonging to investment and business tax classifications were found to reside within a mile of their forested parcels. Generally, when deciding whether an activity is engaged in for profit or not, the IRS considers the presence of recreational and personal motives as an indication of an activity that is conducted without a profit motive (26 CFR 1.183–2). However, forestry is unique in that landowners can manage their forests with a profit motive and still be able to enjoy the aesthetic as well as recreational aspects of their forests.

Given the significance of family forest ownership in meeting the ecosystem service needs of society, including timber products, it is no surprise that the management behavior of family forest owners has been an area of active research. Past studies have noted variation among family forest owners in the country in terms of demographic characteristics, forest ownership attributes, and management objectives. Typologies of family forest ownership mainly based on forest management objectives using some variation of segmentation approaches have been noted before. Our study adds a layer to the existing body of literature highlighting the heterogeneity of family forest owners in the U.S. and their motivations for forest management from a tax categorization perspective. An important application of the results obtained is that they can be used to connect maps of natural disasters to the deductibility of

casualty losses based on our estimates of landowner's tax classification. Our results indicate that the proportion of family forest area and ownership estimated to fall under different tax classifications vary by geographic region. Of the total family forest area held in parcels of 4 hectares more within a geographic region, most of the forest area in the US South (53%), the Pacific Coast (51%), and the Rocky Mountain region (50%) were estimated under investment ownership, while in the US North, it was estimated under personal use ownership (53%). Modification in tax provisions affecting different tax classifications may therefore be felt differently across geographic regions.

Important limitations of the study mentioned above we reiterate here. The categorization criteria used to come up with an estimate of family forest ownership falling under different tax classifications are based on the simplifying assumptions made by the authors based on the review of past literature, relevant court cases, and expert consultation. However, these selected criteria cannot replicate the criteria used by the IRS for determining tax classification of family forest owners (which are more nuanced as IRS considers unique facts and circumstances surrounding an individual taxpayer and their forest activity) and should not be considered so. Further, the proxies used for the categorization are limited by the available information in the National Woodland Owner Survey. Additionally, we have limited our analysis to include only those family forest owners who own forest parcels that are ten acres (four hectares) or larger in size with the assumption that owners with smaller parcels may find it challenging to manage their forests for profit. Our analytical sample limits imply that our results may not be applicable to the 67% of family forest owners owning 7% of total family forestlands in the country in small parcels.

For future research, although no current surveys ask forest owners specifically about tax classifications (and many may not know which classification they fall into), other criteria and thresholds for profit motive and level of activity could be used to estimate the number of owners in each classification and compare to those presented here. Additionally, our estimates can be utilized to determine the economic impact of specific tax provisions. For example, the geospatial overlay of specific natural disasters with these estimates by state or region can determine the fair market value of timber lost that could qualify for casualty loss deductions by forests in the different tax classifications.

CRedit authorship contribution statement

Shivan Gc: Writing – original draft, Visualization, Validation, Investigation, Formal analysis. **Gregory E. Frey:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Christopher Mihiar:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization. **Brett J. Butler:** Writing – review & editing, Software, Methodology, Data curation, Conceptualization. **Consuelo Brandeis:** Resources, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1

Variables based on National Woodland Owner Survey that were used to estimate the proportion of family forest owners under different tax classifications for federal income tax purposes.

Variable	Description	From NWOS response or derived variable	
AC_WOOD	How many acres of wooded land do you currently own in [State]?	NWOS	Integer
OBJ_TIM	How important [is] the following as [a reason] for why you currently own your wooded land in [State]?... For timber products, such as logs or pulpwood	NWOS	Likert Scale 1=Not important to 5=Very important
OBJ_INV	How important [is] the following as [a reason] for why you currently own your wooded land in [State]?... For land investment	NWOS	Likert Scale 1=Not important to 5=Very important
MAN_PLAN	Do you have a written management or stewardship plan for any of your wooded land in [State]?	NWOS	0=No, 1=Yes
MAN_PLAN_IMPLEMENT	If yes, have you taken actions to implement it?	NWOS	0=No, 1=Yes
NTPF_WHY_SALE	Nontimber forest products collected for sale	NWOS	0=No, 1=Yes
ACT_CUT_SALE	Cut and/or removed trees for sale [in past 5 years]	NWOS	0=No, 1=Yes
ACT_RED_FIRE	Reduced fire hazard [in past 5 years]	NWOS	0=No, 1=Yes
ACT_CONTROL_BURN	Controlled burn/prescribed fire [in past 5 years]	NWOS	0=No, 1=Yes
ACT_INVA	Eliminated or reduced invasive plants [in past 5 years]	NWOS	0=No, 1=Yes
ACT_INS	Eliminated or reduced unwanted insects or diseases [in past 5 years]	NWOS	0=No, 1=Yes
ACT_ROAD	Road construction or maintenance [in past 5 years]	NWOS	0=No, 1=Yes
CERT	Is any of your wooded land in [State] currently green certified?	NWOS	0=No, 1=Yes
COST_5YR	Have you used a cost-share program to help you establish or manage your wooded land in [State] in past 5 years?	NWOS	0=No, 1=Yes
LEASE	Have you ever leased or collected money (other than from logging) for allowing people to use your wooded land in [State]?	NWOS	0=No, 1=Yes
LEASE_5YR	Have you leased or collected money (other than from logging) for allowing people to use your wooded land in [State] in past 5 years?	NWOS	0=No, 1=Yes
TAX	Is any of your wooded land in [State] currently enrolled in [a state or local governments program to defer, reduce, or eliminate property taxes for wooded land]?	NWOS	0=No, 1=Yes
CARBON	Is any of your wooded land in [State] currently enrolled in one of these carbon capture programs or markets?	NWOS	0=No, 1=Yes
ADVICE	Have you talked with anyone or received advice/information about care, management, or protection of your wooded land in [State] in the past 5 years?	NWOS	0=No, 1=Yes
CUT	Have any trees been cut or removed from your wooded land in [State] since you have owned it?	NWOS	0=No, 1=Yes
INC_WOOD	On average, what percentage of your household's annual income is derived from the wooded land that you own?	NWOS	Integer 0–100
TIMBER_FOCUS	Production of timber products is considered important or very important	Derived	= 1 if OBJ_TIM >= 4; 0 otherwise
LAND_INVESTMENT_FOCUS	Land investment is considered important or very important	Derived	= 1 if OBJ_INV >= 4; 0 otherwise
NONTIMBER_INCOME	Obtained income from wooded land other than through timber harvest (leasing, enrolling in carbon program, or collecting and selling nontimber forest products)	Derived	= 1 if (NTPF_WHY_SALE = 1 LEASE = 1 CARBON = 1); 0 otherwise
ACT_COUNT	Total count of forest management or income-oriented activities in which the landowner has engaged, out of thirteen selected activities in NWOS survey.	Derived	= MAN_PLAN_IMPLEMENT + ACT_CUT_SALE + ACT_RED_FIRE + ACT_CONTROL_BURN + ACT_INVA + ACT_INS + ACT_ROAD + CERT + COST_5YR + LEASE_5YR + TAX + CARBON + ADVICE

Data availability

The authors do not have permission to share data.

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