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RESEARCH PAPER

Family Forest Owner Characteristics Shaped by Life Cycle, Cohort, and Period Effects

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Abstract Understanding differences and similarities among family forest owners is important in the context of forest land conservation. This study assesses similarities and differences in landowners by analyzing life cycle effects, cohort differences, and period-specific events that shape people's attitudes and behaviors towards their forestland over time. Using data collected by the U.S. Forest Service's 2013 National Woodland Owner Survey, bivariate, random forest and classification tree analyses were used to examine landowners in terms of demographic cohorts. Some attitudes and behaviors of family forest owners were identified as being a result of life cycle (e.g., recreating on their wooded land, plans to transfer land in the next 5 years), cohort (e.g., education level, help with programs or policies), and period (e.g., wars, economic depressions changing attitudes or behaviors) effects. While many of the attitudes and behaviors are common across cohorts. Understanding the reasons for similarities and differences among landowners could help program and policy developers target the appropriate group of people and achieve the highest success rates for policies and programs.

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Introduction

Family-owned forests comprise 36 % of forested land in the United States (Butler et al. 2016a). These private landowners' attitudes and behaviors shape much of what happens to the forests of the United States. Understanding differences and similarities between different groups of landowners is important when trying to promote and improve education, programs, and policies to various groups. In particular, the differences in attitudes and behaviors between cohorts of landowners could have implications for education and outreach as well as program and policy development for forest conservation and management.

Differences in behaviors and attitudes of landowners in different age groups could be a result of numerous factors. Many studies attempt to understand social or demographic change by analyzing life cycle effects, cohort differences, and period-specific events that shape people's attitudes and behaviors over time (Smith 2008; Holford 2014). Our study examines the differences and similarities among forest landowners through this lens to better understand their attitudes and behaviors. 'Life-cycle effects' describe differences in landowners because of their stage in life. For example, young landowners might have a behavior that differs from older landowners today, but as they age, their behaviors might more closely match landowners older than them. 'Cohort effects' describe events that affect a generation when they are young and forming their fundamental values, often influencing their attitudes and behaviors for their entire lives. In this paper, when referring to cohort, we are specifically describing the cohorts defined by generation. An example of a cohort effect would be that acquiring higher education occurs more frequently in younger cohorts than it did in older cohorts. 'Period effects' describe major events (e.g., wars, economic depressions, social movements) that concurrently influence all cohorts. Even though it might be difficult to distinguish the reasons that different cohorts of landowners make decisions, using these various effects as a framework can help describe differences and similarities among landowners as a result of age and generation. To the best of our knowledge, there is a paucity of studies addressing the life-cycle, cohort, and period effects in the natural resource literature and specifically studies related to family forest owner.

The average age of family forest landowners in the United States is 63 years, with 43 % of these landowners older than 65 years and more than 18 % of these landowners 75 years of older (Butler et al. 2016a). The landowners 65 years or older own almost 50 % of the family forest-owned acreage in the country. As family forest owners age, there is an increasingly pressing question of what will happen to their forested land in the future. Being aware of this older demographic when looking at differences and similarities among landowners is important when formulating policies and programs aimed at preserving and managing forests in the future.

In the family forest literature, age is often included as an explanatory variable in models developed to explain various landowner attitudes or behaviors. In many of

these studies, age explains differences in landowner objectives (Majumdar et al. 2009), program enrollment (Bell et al. 1994; Nagubadi et al. 1996; Shivan and Mehmood 2010), and harvesting behaviors or intentions (Joshi and Mehmood 2011; Joshi et al. 2015). However, other articles find that age has no impact on landowner attitudes or behaviors (Janota and Broussard 2008; Leitch et al. 2013; Young et al. 2015). Many of these studies divide landowners into arbitrary discrete age categories (Elwood et al. 2003; Shivan and Mehmood 2010; Fortney et al. 2011), but only a few studies have discussed harvesting behavior as related to life cycle or cohort effects (Kuuluvainen et al. 1996; Kuuluvainen and Tahvonen 1999; Favada et al. 2009; Karppinen 2012). These latter studies consider how landowner age affects frequency of harvest, concluding that younger owners generally tend to cut more frequently; however, the studies were inconclusive when interpreting if the increased harvesting was a result of a life cycle or cohort effect, with either being a possibility. All of the articles including landowner age provide valuable information on the effect of age on particular programs, policies, or other attitudes and behaviors, focusing on one landowner behavior or attitude. Little research has been done to understand differences and similarities among cohorts' attitudes and behaviors toward forestry, owning land, or conservation. It is interesting to look specifically at cohorts because there are characteristics of different cohorts that likely have implications for the design and implementation of programs and policies. For example, different cohorts have varying propensities for communicating and trusting specific information channels (Pew Research Center 2010). Some cohorts are more utilitarian, while others are more prone to use experts and fee-for-service programs, in other parts of their lives (Pew Research Center 2010) and presumably in relation to their forests as well. There has been some research done on different environmental attitudes and behaviors of people of different ages (Nord et al. 1998; Torgler et al. 2008), where age had a significant negative relationship with environmental concern; however, it is unclear if this translates to differences across cohorts as well.

The U.S. Forest Service's 2013 National Woodland Owner Survey (NWOS) (see Butler et al. 2016b for more information about NWOS) was used to analyze life cycle, cohort, and period effects of landowner attitudes and behaviors. Because the survey reaches forest landowners across the age spectrum, we can analyze their characteristics to examine which attitudes and behaviors might be specific to a particular age or cohort of landowners and which characteristics might be common across the ages and cohorts of landowners, due to period effects or other commonalities. Our objectives are to describe the different groups of landowners based on life cycle, cohort, and period effects, discerning what attitudes and behaviors might be important when defining characteristics of groups of family forest owners.

Methods

National Woodland Owner Survey

The 2013 National Woodland Owner Survey (NWOS) data of family forest ownerships with 4+ hectares (10+ acres) of land was used to examine

characteristics of different cohorts of landowners. The NWOS is conducted by the U.S. Forest Service, Forest Inventory and Analysis (FIA) program to increase the understanding of the attitudes, behaviors, and demographics of private forest-land ownerships across the United States. A total of 8576 family forest owners with 4+ ha responded to the survey with an overall cooperation rate of 51.6 %. These responses include telephone follow-up interviews conducted with 12 % of the mail survey nonrespondents used to increase response rates and test for nonresponse bias. Because no clear nonresponse bias was found, no adjustments were made to the estimates (Butler et al. 2016b).

The sample points were chosen using a probability-based sampling design. The sampling design used for the NWOS is built upon the sampling framework used for FIA forest resource monitoring (Bechtold and Patterson 2005; Dickinson and Butler 2013). For detailed information on the NWOS sampling procedures and implementation, please refer to Butler et al. (2016c) and Dickinson and Butler (2013).

Variable Definitions

The landowners were divided into cohorts based on definitions from the Pew Research Center (2010). The cohorts are defined as: Millennial Generation: born 1980–1997; Generation X: born 1965–1980; Baby Boomer: born 1946–1964; the Silent Generation: born 1928–1945; the Greatest Generation: born before 1928. These cohorts are commonly cited in the USA and can be defined slightly differently, and as there is no official demarcation of the cohorts, we adapted the Pew Research Center definitions. The cohort of the NWOS survey respondents was used as the dependent variable in our analysis. Because the sample size for the Millennial Generation was so small (n = 34) (Table 1), they were excluded from the analyses.

Forty-five independent variables from the NWOS were used to analyze similarities and differences among cohorts of landowners (Table S 1). The independent variables can be grouped into 5 categories: general landowner characteristics, landowner objectives and concerns, forest management descriptors, forest use behaviors, and land-use characteristics. Three variables were used to describe general landowner characteristics, including size of forest holdings, if the

Table 1 Population-level estimates of the cohorts of landowners and sample size used in analyses

Generation	Years	Estimated number of family forest ownerships	Ownership percent	Sample size
Greatest	Born before 1928	133,000	4	320
Silent	1928–1945	1,136,000	35	3119
Baby Boomers	1946–1964	1,734,000	53	2340
Generation X	1965–1980	235,000	7	320
Millennial	1981–present	22,000	1	34

landowner's home is near their wooded land, and education. These variables were included to examine if basic landowner characteristics differ among cohorts.

Thirteen variables were used to describe landowners' objectives, and three variables were used to describe landowner concerns (Table S 1). There is evidence of owner objectives varying by age in the family forest literature (i.e., Majumdar et al. 2009), and we are interested in determining if objectives and concerns might also vary by generation.

Seventeen variables were used to describe landowners' management behaviors: advice topics and methods in the past 5 years, how the landowner prefers to get advice and assistance, enrollment in a green certification program, enrollment in a tax program, landowner having an easement on their property, having a management plan, and involvement in a cost-share program (Table S 1). Six variables were used to describe landowners' forest use practices: landowner ever harvesting timber for sale, landowner ever harvesting timber for personal use, landowner harvesting timber in the past 5 years, landowner ever harvesting nontimber forest products for sale, landowner ever harvesting nontimber forest products for personal use, and landowner and/or landowner's spouse recreating on their wooded land (Table S 1). In the literature, age is often used as a predictor variable for various forest management or forest use behaviors (Nagubadi et al. 1996; Arano et al. 2004; Janota and Broussard 2008), and a suite of these variables were included in this study to see if there are similar associations between forest management/use and generation.

Also included were three variables that describe the landowner's interest in conserving their forestland: landowner's interest in keeping their land wooded, landowner's interest in selling their land if offered a reasonable price, and likelihood of transferring land in the next 5 years (Table S 1). Understanding differences in land-use attitudes and likelihood of land transfer between cohorts is important to the future of family forest lands.

Statistical Methods

A suite of statistical tools was used to determine associations among multiple variables and the different cohorts of landowners. First, bivariate statistics were used to examine the relationship between each variable and generation to determine how they relate to each other. To look at the multivariate relationships, random forest and classification tree analyses were used (Hothorn et al. 2015). Previous studies have used logistic regression or multinomial regression models to understand the relationships between family forest owner behaviors and attitudes and various independent or predictor variables (i.e., Arano et al. 2004; Kaetzel et al. 2011; Ruseva et al. 2015). In this study, we used random forest and classification tree analyses to avoid the necessity of conforming to the more restrictive assumptions associated with regression models. We also believe the random forest and classification tree analyses are superior in the given circumstances because we will be able to clearly see the variables important in distinguishing cohorts from each other and what characteristics are unique to particular cohorts of landowners. Random forest and classification tree analyses used the independent variables to

classify people into each generation. The random forest analysis examined which variables were the most discerning when it comes to identifying the different cohorts, and then these important variables were used to create a conditional inference tree, which predicts the distributions of the different cohorts based on specific combinations of these variables. The combination of variables that are most associated with the different cohorts can be determined using these methods.

Bivariate Comparisons

Relationships between the continuous variable and generation were examined using a point-polyserial correlation coefficient calculated using the 'polycor' package in R (Fox 2010) and among categorical variables and generation using a Chi squared test for independence in R (R Core Team 2014). After adjusting for item nonresponse, the sample size was 6181 respondents. For the bivariate comparisons, we were interested in landowners' strong attitudes. For this reason, variables with a five point Likert scale were collapsed into binary variables, where landowners with the two highest Likert scale options were given a "1" and landowners who answered in in the lowest three Likert scale options were given a "0". We used an experiment-wise error rate of $p < 0.05$ to test for significance.

Random Forest and Classification Tree Analyses

Random forest and classification tree analyses were used to better understand which attitudes and behaviors are important to each of the landowner segments. Random forest analysis generates multiple conditional inference trees based on subsets of the data to determine the best variables for discriminating among cohorts. Using the PARTY package in R (Hothorn et al. 2015), the random forest analysis combined a series of conditional inference trees that were sampled independently and without replacement to determine the most important variables for partitioning the data into the four cohorts. For each tree, the variable at each node was chosen at random to determine the relationships among dependent and independent variables. A 'node' refers to a split in the dataset at a particular variable, where the distribution of cohorts was significantly different on each side of the split. From the series of conditional inference trees, the most important variables that create the most accurate classification of the dependent variables were identified (Hothorn et al. 2006). The full set of input variables was used in the random forest analysis (Table S 1). To identify the most important variables, variables that were at least 20 % of the maximum importance value were chosen. The 20 % cut-off value was chosen to best represent the most important variables in this data set.

Classification tree analysis is a non-parametric model that recursively partitions a dataset using explanatory variables to predict the distribution of dependent variables into terminal nodes; we implemented this using the PARTY package in R (Hothorn et al. 2015), which uses a conditional inference tree algorithm. The goal of a classification tree is to predict the proportion of each classifying variable in the data set in unique groups based on a set of input variables. The classification tree analysis will predict the distribution of landowners in each generation based on their

attitudes and behaviors toward their woodland, using the most important variables determined by the random forest analysis. Because there were so many significant nodes, a p value of 0.0001 was used to examine only variables with a high level of significance in the tree. The classification tree uses an algorithm to choose only the most significant variables for classifying landowners into cohorts; therefore, not all variables used as input into the classification tree appear in the output.

Results

Bivariate Comparisons

Examining how each variable differed across cohorts, there are significant differences ($p < 0.05$) between at least two of the cohorts in 40 of the 45 variables we examined (Table 2). In addition, all of the categories of variables (general landowner characteristics, objectives and concerns, forest management, forest use, and land-use) have some significant differences among cohorts (Table 2).

Variables with significant differences across all four cohorts include landowners who have recreated on their land, those that have cut or removed timber for sale, and landowners who are likely to transfer land in the next 5 years (Table 2). Generation X has the highest percentage of landowners who have recreated on their wooded land (86 %), while the Greatest Generation has the lowest percentage (44 %). The Greatest Generation has the highest percentage of landowners who have harvested timber for sale on their land (65 %), and Generation X has the lowest (37 %). Not surprising given their age, the Greatest Generation has the highest percentage of landowners who are likely to transfer land in the next 5 years (31 %), while Generation X has the lowest percentage (9 %). We also see many variables that show differences between the younger and older cohorts, such as rating cost-share programs for woodland management or more favorable tax policies as helpful, concern about development, preferring to get advice and information from written materials and the internet, and cutting trees on their land for personal use. In all of these cases, Generation X and the Baby Boomers have a significantly higher percentage of landowners than the Silent or Greatest Generations. There are also variables that show no differences across cohorts, including if the landowner's home is near their wooded land, if advice on transferring land to the next generation would be helpful, if stronger timber markets would be helpful, concern about keeping land intact for future cohorts, enrollment in a tax program, having a conservation easement or management plan, and if the landowner would sell their land if offered a reasonable price.

Random Forest and Classification Tree

The random forest analysis used 6181 observations and 41 variables to identify the most important variables for partitioning family forest ownerships by cohorts. We identified 10 variables that were at least 20 % of the maximum importance value, as the most important variables and the best at discerning between cohorts of landowners. The most important variable was if the landowner preferred to get

Table 2 Bivariate analyses of cohorts and independent categorical variables

Variable	Level	a. Generation X	b. Baby Boomers	c. Silent Generation	d. Greatest Generation
Home near wooded land	Yes	60	60	60	61
Primary owner education	College degree	57[c,d]	58[c,d]	49[a,b,d]	39[a,b,c]
Objective: Beauty	Very important or important	82[c,d]	82[c,d]	74[a,b]	67[a,b]
Objective: Nature	Very important or important	69	73[d]	67[c]	65
Objective: Water	Very important or important	60[b,c]	67[a]	64[a]	62
Objective: Wildlife	Very important or important	80[c,d]	79[c,d]	75[a,b,d]	69[a,b,c]
Objective: Privacy	Very important or important	71[c,d]	70[c,d]	59[a,b,d]	51[a,b,c]
Objective: Family	Very important or important	57[b,c,d]	46[a,c]	39[a,b,d]	42[a,c]
Objective: Hunting	Very important or important	63[b,c,d]	55[a,c,d]	49[a,b]	42[a,b]
Objective: Recreation	Very important or important	66[b,c,d]	55[a,d]	42[a]	37[a,b]
Objective: Fire	Very important or important	23[d]	26	24	22[a]
Objective: NTFP	Very important or important	10[d]	9[d]	7[d]	6[a,b,c]
Advice in past 5 years	Yes	36	38[c]	34[b]	34
Advice on woodland management	Very helpful or helpful	65[b,c,d]	55[a,c,d]	46[a,b]	43[a,b]
Advice on transfer land	Very helpful or helpful	52	50	45	45
Advice on easements	Very helpful or helpful	24	23[d]	20	19[b]
Cost-share for woodland management	Very helpful or helpful	50[c,d]	46[c,d]	33[a,b]	29[a,b]
More favorable tax policies	Very helpful or helpful	75[c,d]	72[c,d]	61[a,b]	53[a,b]
Stronger timber markets	Very helpful or helpful	48	47	45	46
Prefer advice/info from talking to someone/visit land	Yes	57[c,d]	51[c]	45	41
Prefer advice/info from written materials	Yes	67[c,d]	63[c]	56	55
Prefer advice/info from the internet	Yes	38[c,d]	35[c,d]	17	13
Wants no advice or information	Yes	5[b,c,d]	10[c,d]	19	23
Concern about development	Great concern or concern	47[c,d]	48[c,d]	38[a,b]	29[a,b]
Concern about heirs	Great concern or concern	78	79	78	80

Table 2 continued

Variable	Level	a. Generation X	b. Baby Boomers	c. Silent Generation	d. Greatest Generation
Concern about climate change	Great concern or concern	28[b,c,d]	35[a]	33[a]	31[a]
Has green certified wooded land	Yes	2[b,c,d]	5[a,d]	5[a]	6[a,b]
Is enrolled in a tax program	Yes	24	27	27	22
Has a conservation easement	Yes	5	5	5	5
Has participated in a cost-share program	Yes	16[c,d]	19	21[a]	22[a]
Has a management plan	Yes	28	29	28	27
Has cut on their wooded land for sale	Yes	37[b,c,d]	43[a,c,d]	53[a,b,d]	65[a,b,c]
Has cut on their wooded land for personal use	Yes	64[c,d]	64[c,d]	57[a,b]	51[a,b]
Has cut wood on their land in the past 5 years	Yes	65[c]	61[c]	55[a,b]	57
Has collected NTFP for sale	Yes	5[c,d]	6[c,d]	6[a,b]	7[a,b]
Has collected NTFP for personal use	Yes	40[c]	38[c]	32[a,b]	30
Has personally recreated on their land in the past 5 years	Yes	86[b,c,d]	79[a,c,d]	65[a,b,d]	44[a,b,c]
Wants their land to stay wooded	Strongly agree or agree	89[d]	88[c,d]	85[b]	83[a,b]
Would sell their land if offered a reasonable price	Strongly agree or agree	23	25	22	16
Transfer land in the next 5 years	Extremely likely or likely	9[b,c,d]	15[a,c,d]	24[a,b,d]	31[a,b,c]

Below is the percent of each generation that falls into each variable category and the statistical differences between cohorts for each variable ($p < 0.008$: experiment-wise error rate) based on Chi-square tests

Statistical differences at the $p < 0.008$ level

[a] Significantly different than Generation X

[b] Significantly different than Baby Boomers

[c] Significantly different than Silent Generation

[d] Significantly different than Greatest Generation

advice or information from the internet, followed by whether or not the landowner and/or their spouse had recreated on their wooded land in the past 5 years. The other variables, in order of importance, include: if the landowner plans to transfer land in the next 5 years, recreation as an objective for owning woodland, if the landowner had ever cut or removed trees for sale, if cost-share programs would be helpful, privacy as an objective for owning woodland, size of forest holdings, concern about development, and landowner education (Fig. 1).

The classification tree used 6181 observations and the 10 most important variables as determined by the random forest analysis to partition the ownerships (Fig. 2). A total of 13 terminal nodes were identified in the final model. The highest node, where there is the biggest significant difference between cohorts, is whether or

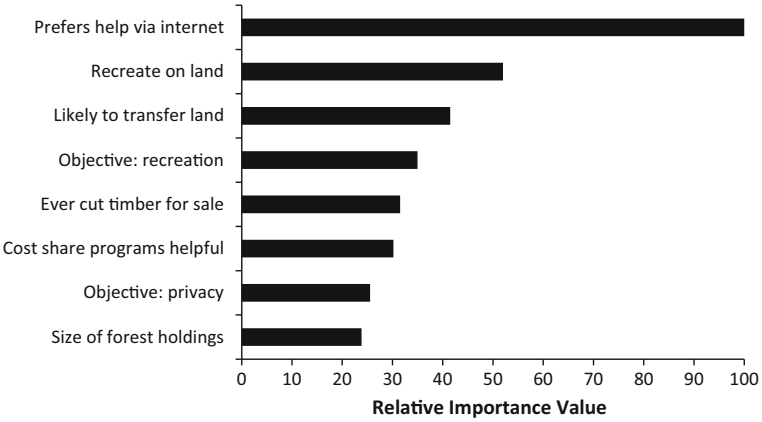

Fig. 1 Relative importance of variables from random forest classification tree model. The *values* represent the importance values divided by the maximum importance value multiplied by 100

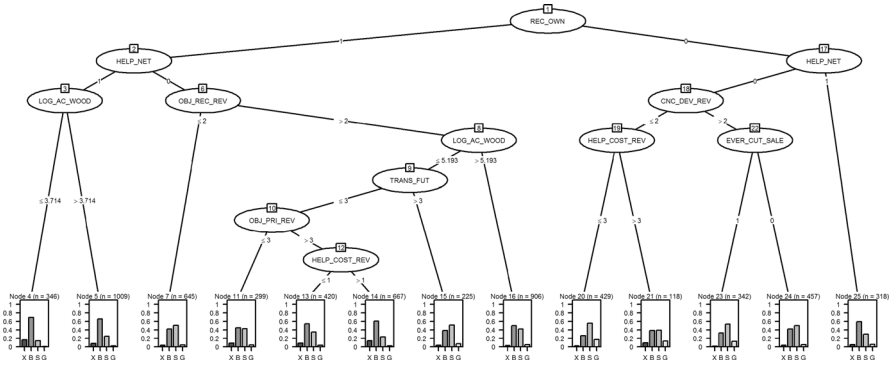

Fig. 2 Classification tree showing the relationship between variables ranked as important by the random forest analysis (Fig. 1) and different cohorts of family forest owners. Partitions represent statistically significant splits at the $p = 0.0001$ level. End node labels correspond to the different cohorts: *X* Generation X, *B* Baby Boomers, *S* Silent Generation, *G* Greatest Generation

not the landowner and/or their spouse had recreated on their wooded land in the past 5 years. Other variables retained in the model are if the landowner prefers to get advice and information from the internet, if the landowner had ever harvested or removed timber for sale, size of forest holdings, if they thought cost-share programs would be helpful, privacy as an important objective for owning land, recreation as an important objective for owning land, concern over development, and if the landowner is likely to transfer their land in the next 5 years. The variables that identified as important by the random forest analysis, but are not then included in the classification tree analysis are not necessarily unimportant in classifying landowners. A classification tree identifies the variables to best split the data; however, an alternative variable may have given a similar split in the data.

To illustrate classification tree analysis and interpretation, we will follow one pathway down from the top node to its terminal nodes. Out of all the respondents, 57 % were predicted to recreate on their own land. If the landowner had recreated on their land, the next split was based on the respondent's preference to receive advice and information from the internet. Of the landowners that do recreate on their own land, Generation X has the highest percent of landowner that would prefer information or advice over the internet (39 %), while the Greatest Generation has the lowest percent of landowners who prefer this method of advice (15 %) (Fig. 2). The next split was based on size of forest holdings. We see in general, that landowners from the Silent and Greatest Generation are more likely to have larger (approximately 10 ha) forest holdings than younger cohorts. This result is understood when comparing the cohorts in the end nodes 4 and 5. The relative proportions increase for the Silent and Greatest Generations when comparing those who have smaller size of forest holdings (end node 4) to those who have larger size of forest holdings (end node 5), while the relative height of these bars decrease when looking at Generation X and the Baby Boomers. From this, we can conclude that the older cohorts are more likely to have larger size of forest holdings than the younger cohorts (Fig. 2).

Discussion

Understanding differences and similarities in landowner attitudes and behaviors is important when determining how their actions might influence the landscape and what programs and policies can in turn influence their actions. Understanding which of the differences among landowners can be attributed to their life cycle stage, cohort, or period in time is important for understanding how land might be transferred in the future, as well as for education and outreach. Here, we examined what characteristics are associated with life cycle, cohort, and periodicity effects.

Life Cycle Effects

Life cycle effects describe differences in landowners based on their stage in life—which is obviously highly correlated with age. For example, landowners often follow similar trajectories through life, which could include marriage, having children, and retirement. Life cycle effects describe attitudes and behaviors that

might change through time as landowners reach these different stages in life. The highest node in the classification tree was if the landowner or landowner's spouse had recreated on their wooded land in the past 5 years. The Silent and Greatest Generations are less likely to recreate on their own land. The older cohorts of landowners are also less likely to rate recreation as an important objective for owning their woodland, although this result did not show up in the classification tree analysis. The negative relationship between generation and recreation is likely due to a life cycle effect. As landowners age, being able to hunt, fish, hike, ski, or recreate using off-road vehicles might become more difficult or less desirable. Joshi and Arano (2009) also found that younger landowners were more likely to manage their forest for recreation improvement activities than older landowners.

Plans to transfer land in the next 5 years is likely a life cycle effect also. As landowners age, the likelihood that they are concerned with what will happen to their land in the future increases. Even though the Greatest Generation is the most likely to transfer their land in the near future, almost 70 % of respondents in this generation are undecided or unlikely to transfer their lands in the next 5 years, which could have implications for the future of these family forest lands. While plans to transfer land in the next 5 years differ among cohorts, this does not correspond to differences in how helpful landowners rate advice on how to transfer land to the next generation. Younger cohorts rated programs or advice as helpful more often than the older cohorts, so it will be interesting to see if, when these younger cohorts become interested in transferring land as they age, they are more likely to think that advice on how to do so would be helpful as well.

In general, younger cohorts rated programs or advice as helpful more often than the older cohorts. It is unclear if this is because the younger cohorts have less experience and are more eager for help and advice—making this a life-cycle effect, or if the younger cohorts are more likely to be interested in services than the older cohorts due to a cohort effect. If this is a cohort effect, tailoring programs and policies to Generation X and the Baby Boomers might be more successful than to the general landowner population. However, if this is a life cycle effect, programs and policies might do better to target landowners of younger age classes than specific generational groups.

Another forest use variable that is likely due to a life cycle event is harvesting timber. Older landowners are more likely to have cut timber on their property. This also might be related to the number of years a landowner has owned wooded land—often older landowners have a longer tenure—giving them more time to have harvested timber. If this is a life cycle effect, we would expect younger landowners to be more likely to harvest timber from their land as they age. Some studies have found harvesting behaviors are negatively related to age (Loeyland et al. 1995; Kuuluvainen et al. 1996; Zhang and Flick 2001; Karppinen 2012) while other studies have found a positive relationship between age and timber harvesting (Conway et al. 2003; Gan and Kebede 2005). These studies define age categories differently as well as ask slightly different questions (e.g., frequency of harvests versus size of harvests), making direct comparisons difficult. It makes sense that the forest use variables would be negatively associated with age—with the older cohorts

using their forest less than younger cohorts, or potentially being more financially stable and needing less income from their land.

Owning woodland to raise a family is also likely a life cycle event. Although this variable is not retained in the classification tree analysis, it is one of the important variables identified in the random forest analysis. We see that, while most landowners do not rate raising a family as one of their top reasons for owning woodland, younger cohorts tend to think this reason is more important than older cohorts. This makes sense, as older cohorts are likely to have already raised their families, and we would expect younger cohorts to rate this reason for owning woodlands as less important as they age.

Cohort Effects

Cohort effects describe events that affect a generation when they are young and forming their core values, often influencing their attitudes and behaviors their entire lives (Pew Research Center 2010). Cohort effects refer to differences unique to each generation. We suggest a group of variables that discriminate between cohorts that are likely a result of cohort effects. These include demographic variables (landowner education level and acres of wooded land), forest policy/advice variables (help with cost share programs, advice on woodland management, and more favorable tax policies), landowner objectives (privacy), and concerns (concern about development).

A landowner's preferred method of receiving information or advice is likely a cohort effect. Generation X and the Baby Boomers were introduced to the internet at a younger age, and as a result, they are more likely to prefer this method of receiving information. In fact, a larger percentage of Generation X and the Baby Boomers preferred to receive advice and information through the internet, talking to someone or having someone visit their land, and written materials and brochures than the Silent and Greatest Generation, while the Silent and Greatest Generations were more likely to say that they didn't need or want information or advice than the younger cohorts. This characteristic might be a life cycle effect, where, as landowners age and gain more experience or are less active on their land, the need for information and advice decreases.

In general, younger cohorts of landowners are more educated than older cohorts of landowners. This trend in landowner education follows the more general trend of education among the different cohorts across the U.S. (Pew Research Center 2010). Younger cohorts have had more access to higher education, and it is more common that people in younger cohorts continue on with higher education (Pew Research Center 2010). Karppinen (2012) found that younger forest owners often had a better education. Understanding the general trends of education among cohorts of landowner is important when developing education and outreach materials directed at a particular group.

Various studies have shown positive relationships between willingness to participate in cost-share programs, such as programs promoting bioenergy or forest management plans, and age (Bell et al. 1994; Nagubadi et al. 1996; Shivan and Mehmood 2010), which the authors attribute to increased experience with age. We found no difference in cohorts of landowners who actually participate in cost-share programs, but we see that younger cohorts think that cost-sharing for woodland

management would be more helpful than older cohorts. Rating cost-share programs as helpful could be a life cycle event or a cohort effect. As a life cycle effect, if the younger cohorts of landowners tend to have more financial constraints (Karppinen 2012), cost-share programs may be more appealing to them when younger, but in the future as they gain more experience and fewer financial constraints, they maybe less inclined to think these programs would be helpful. Interpreted as a cohort effect, the landowners in these younger cohorts may now believe that cost-share programs would be helpful, and in the future, they might be more inclined to participate in these programs than older cohorts were. The same logic can be applied to younger landowners thinking that advice on woodland management and more favorable tax policies would be helpful—if their thinking changed with age and experience, these would be considered life cycle effects. If these opinions on program and advice helpfulness remain, these would be considered cohort effects, and we would expect more landowner participation in programs in the future from these cohorts. Following landowners through time is one way we can distinguish whether desire to receive advice or help is an age- or generation-specific quality.

Younger cohorts rate privacy as a reason for owning woodlands higher than older cohorts. It is possible that younger cohorts seek out forests for more privacy, while landowners in older cohorts own woodlands for other reasons—maybe owning woodlands was part of their livelihood. Majumdar et al. (2009) also found that age is negatively related to privacy, where landowners aged 65–74 generally did not own their woodland for privacy, and landowners aged 35–44 were more likely list privacy as a reason for owning woodlands.

Concerns about development are rated higher with the younger cohorts of landowners than the older cohorts. Development of forests has greatly increased in the United States, which can lead to environmental threats such as loss of ecosystem services (Radeloff et al. 2005). Because development is more prevalent now, this could be considered a cohort event that will shape younger cohorts of landowner's concerns into the future as well.

Larger acreages of wooded land are associated with the older cohorts. Owning larger acreages could be associated with life cycle or cohort effects. It's possible that larger parcels of land were available to older cohorts of landowners, and with the increase in development and parcellation in recent years (Mundell et al. 2010; Sanborn-Stone and Tyrrell 2012), only smaller parcels of land are available to younger cohorts, making this a cohort effect. If this is a cohort effect, we would expect the younger cohorts of landowners to maintain smaller acreages of forest land over time. However, because age is correlated with tenure, older cohorts may have also accumulated land over the years, making it possible that this is also a life cycle effect. If this is a life cycle effect, we would expect younger cohorts of landowners to acquire more land over time as they age.

Period Effects

Period effects describe major events (e.g., wars, economic depressions, social movements) that concurrently influence all cohorts (Pew Research Center 2010). Many of our input variables did not vary across cohorts based on the random forest

and classification tree analysis. These could be attitudes and behaviors shared between these groups of landowners based on period effects or other commonalities. Some of the least important variables when discriminating between cohorts include landowners wanting their land to stay wooded, reasons for owning woodlands, including for beauty, firewood, and wildlife habitat, participation in programs, such as conservation easements, green certification and cost share programs, and concern about climate change and keeping land intact for future cohorts. Some of these variables are low across all cohorts, such as participation in forest management programs, while others are high across all cohorts, such as landowners wanting their land to stay wooded. It is plausible that some of these variables that do not show up as important when distinguishing cohorts of landowners in the models are due to period effects. However, it is also possible that these variables are just common characteristics, attitudes and behaviors across all cohorts of landowners.

Policy Implications

Understanding landowner attitudes and behaviors is critical when shaping educational and outreach programs, as well as policies. The characteristics that differentiate the cohorts of landowners are important to keep in mind when developing or implementing these programs or policies. By discerning which landowner characteristics are functions of age versus cohort, policy and program developers can begin to target certain groups of landowners for specific programs. Characteristics influenced by life cycle effects, or age, can be used when developing programs for the younger or older demographics. Similarly, if a characteristic is specific to a particular generation, we can target programs toward those cohorts where they will be most effective.

Programs that would likely increase in effectiveness if targeted toward certain ages of landowners include recreation-centered programs, programs that focus on harvesting timber for personal use, or for sale, and programs aimed at land transfer. For example, a recreation-focused outreach program would likely be less effective for older landowners than younger landowners. Similarly, older landowners are more likely to transfer their land in the next 5 years, and aiming bequest or easement programs toward these older landowners would likely be more effective than targeting younger landowners.

Targeting particular cohorts may be beneficial for other policies and programs. For example, more landowners from Generation X and the Baby Boomers thought that more favorable tax policies would be helpful than landowners in the Silent or Greatest cohorts; therefore, directing tax programs toward Generation X and Baby Boomers could be more effective than targeting the Silent or Greatest Generations. Generation X and the Baby Boomers also tend to have higher levels of education than the Silent and Greatest generations. This information could affect how program and policy developers market these programs.

It is not always clear if a landowner characteristic is a product of their cohort or a function of age. In these cases, it may be best to develop programs more generally, targeting landowners who we currently know are most interested, but leaving the program open for change in the future, in the case that it would be more effective to tailor the program toward a specific cohort or a certain age class of landowner. For

example, younger landowners in Generation X and the Baby Boomer generation thought that cost-share programs would be helpful. Program developers can target these landowners now, and in the future, reevaluate to see if these cohorts still think cost-share programs would be helpful as they age.

It is also important to consider the variables that are common across cohorts. For example, very few landowners in any generation have a conservation easement. Targeting easements based on cohort might not be the most effective way to increase participation. Instead, willingness to sell or give away development rights might be more associated with a different grouping of landowners.

A large part of introducing or implementing policies and programs is actually reaching receptive landowners. There was no difference between cohorts of landowners receiving advice in the past 5 years. However, Generation X and the Baby Boomers were more likely to think that various programs or advice would be helpful than the Silent or Greatest cohorts. It is plausible that seeking out help is something that changes as a landowner ages and gains experience (life cycle effect) or that it is a difference between the cohorts that will remain through time (cohort effect). The method of reaching out to landowners is also important to policy and program developers. Generation X and the Baby Boomers are more likely to say they preferred receiving information and advice through the internet, from written materials, and from talking to someone or having someone visit their land. The Silent Generation is more likely to not want or need information or advice. While some of these advice methods seem to be a cohort effect (i.e., receiving advice from the internet), others might be a factor of life cycle (i.e., not wanting any advice).

Conclusions

Certain variables are clearly associated with specific cohorts, such as landowners recreating on their land, timber harvesting, and helpfulness of certain programs or advice. However, many of the variables used in our analyses could not be used to distinguish among the cohorts of landowners. While understanding what makes the cohorts different from each other can be important when directing education, outreach, policies, and programs towards landowners, it is equally important to understand what these different cohorts of landowners have in common.

Understanding differences in landowner attitudes and behavior is often done with typologies (i.e., Boon et al. 2004; Butler et al. 2007; Majumdar et al. 2007, 2008), and it is likely that these different segments of landowners exist in each cohort. It is also likely that other life events, such as having children, paying for medical expenses or college tuition, and retirement might shape landowner attitudes and behaviors in ways we can't distinguish when looking at cohort alone.

While this analysis explores landowners in the United States, understanding landowner trends is important on a global scale. There can be substantial differences in what defines different cohorts of people in different countries, based on unique experiences in their youth (Erickson 2011). Understanding the differences and similarities among life cycles, cohorts, and period effects in different countries can add insight to the attitudes and behaviors of landowners globally.

Longitudinal studies of landowners would be a more direct way to assess of differences in life cycle, cohort, and period effects. By following groups of landowners through time, we can better gauge how their attitudes and behaviors change, and which characteristics can be attributed to landowners aging verses fundamental differences among the cohorts. Looking at landowners through a framework of life cycle, cohort, and period effects hopefully sheds light on why there are differences and similarities among cohorts of family forest owners, which has implications for education and outreach as well as program and policy development for forest conservation and management.

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