Landscape and Urban Planning xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

Family-forest owner decisions, landscape context, and landscape change

Kathleen P. Bell[a,*], Marla Markowski-Lindsay[b], Paul Catanzaro[b], Jessica Leahy[c]

[a] School of Economics, University of Maine, Orono, ME, USA
[b] Department of Environmental Conservation, University of Massachusetts, Amherst, MA, USA
[c] School of Forest Resources, University of Maine, Orono, ME, USA

ARTICLE INFO

Keywords:
Family-forest owners
Landscape change
Estate planning
Conservation easements
Preferential tax programs
Landscape context

ABSTRACT

We examined broad-scale patterns in family forest owners' decisions to use estate planning and conservation tools, and participate in preferential tax programs in eight forested landscapes of the United States. We focused our analyses on patterns across regions and states, and scrutinized the impacts of adding regional and state fixed effects to discrete choice models of owner behaviors. We used chi-square testing and binary discrete choice models to analyze mail-survey responses collected from landowners. Our exploratory research revealed distinct broad-scale patterns by owner decision, with the strongest evidence of state and regional variation in owner participation in preferential tax programs and some evidence of such variation in decisions to use wills and trusts. In contrast, we detected no such differences when examining decision-making about conservation easements across regions or states. Our findings in support of state and regional effects suggest forested landscape contexts beyond owner and parcel characteristics matter and could potentially drive differences in behaviors and forest outcomes. Measures of regional and state fixed effects can provide useful information about contextual differences across forested landscapes, such as differences in public programs and engagement aimed at owners. They can also inform the appropriateness of transferring insights across landscapes. Building on these findings, we share guidance for future data collection and research, including how improved monitoring and greater consideration of contextual factors beyond individual and ownership characteristics could enhance understanding of family forest owner decision-making and landscape change.

1. Introduction

Of many human drivers of landscape change, family forest owners uniquely impact forest systems as millions of individuals make critical decisions about the use and ownership of their lands. Collectively, these family forest owners' decisions, including whether to sell or develop forest lands, whether to pass on their forests to heirs, and how to manage forests, affect the magnitude, timing, and distribution of landscape change (Butler et al., 2016b; Stein et al., 2005). Owner decisions help accelerate or attenuate varied forms of change and disturbance, including land conversion (Alig, Kline, & Lichtenstein, 2004; Mundell, Taff, Kilgore, & Snyder, 2010), land conservation (Mitani & Lindhjem, 2015; Song, Aguilar, & Butler, 2014), fire potential (Fischer & Charnley, 2012; Jarrett, Gan, Johnson, & Munn, 2009), and the spread of invasive pests and plants (Ma, Clarke, & Church, 2018). Hence, enhancing understanding of family forest owners as drivers of landscape change provides managers and other decision-makers with key information about the spatial and temporal dynamics of forest systems.

We examined estate planning and conservation decision-making among family forest owners because of the connections between such decisions, forests, and landscape change. Estate planning decisions related to future land ownership and use influence owner transitions and, in some instances, the persistence of family forests. Decisions to donate or sell conservation easements or participate in preferential tax programs also impact forest persistence by restricting developed uses or favoring particular undeveloped uses of forest lands. New work is beginning to fill in critical information gaps about conservation-oriented estate planning decisions made by family forest owners (e.g., Catanzaro, Markowski-Lindsay, Milman, & Kittredge, 2014; Creighton, Blatner, & Carroll, 2016; Gruver, Metcalf, Muth, Finley, & Luloff, 2017; Markowski-Lindsay et al., 2017). Such decisions are distinguished from conventional estate planning activities because they specifically involve the future use and ownership of lands. Relative to estate planning, more is known about family forest owners' use of conservation easements (e.g., Butler et al., 2016b; Farmer, Knapp, Meretsky, Chancellor, &

* Corresponding author at: School of Economics, University of Maine, 5782 Winslow Hall, Orono, ME 04469-5782, USA.
E-mail addresses: kpbell@maine.edu (K.P. Bell), marla@eco.umass.edu (M. Markowski-Lindsay), paulcat@umass.edu (P. Catanzaro), jessica.leahy@maine.edu (J. Leahy).

https://doi.org/10.1016/j.landurbplan.2018.08.023
Received 16 January 2018; Received in revised form 6 June 2018; Accepted 12 August 2018

Fischer, 2011; Kelly, Germain, & Mack, 2015; Kittredge, Gianotti, Hutrya, Foster, & Getson, 2015; LeVert, Stevens, & Kittredge, 2009; Ma, Butler, Kittredge, & Catanzaro, 2012) and participation in preferential tax programs (e.g., Fortney, Arano, & Jacobson, 2011; Hibbard, Kilgore, & Ellefson, 2003; Kilgore, Ellefson, Funk, & Frey, 2016; Kilgore, Greene, Jacobson, Straka, & Daniels, 2007). As researchers further expand their study of owner decisions beyond timber harvesting (Beach, Pattanayak, Yang, Murray, & Abt, 2005; Fischer, Bliss, Ingemarson, Lidestav, & Lönnstedt, 2010; Silver, Leahy, Kittredge, Noblet & Weiskittel, 2015) and resource managers engage with owners about multiple objectives and diverse tools and programs (Butler et al., 2016b), knowledge of the linkages between family forest owner decisions and landscape change improves. Yet, it remains important to understand to what extent these tools and programs and related owner decisions are playing out differently across different landscapes.

We examined broad-scale patterns in family forest owners' use of estate planning and conservation tools across eight forested regions spanning four Northeastern US states. We examined these usage patterns to assess similarities and differences across forested landscapes and tools and to look for evidence of state and regional contextual effects above and beyond the effects of owner and ownership characteristics on use and participation decisions. Studying estate-planning and land conservation decisions allowed us to compare and contrast patterns for distinct types of decisions, including the use of wills, trusts, and conservation easements and participation in preferential tax programs. Together, these exploratory research activities helped us gauge the potential significance of landscape context as a mediating influence on the role of family forest owners as drivers of landscape change.

2. Methods

2.1. Study area and regions

We studied the decision-making of family forest owners with lands located in Massachusetts, Maine, New York and Vermont, United States. Family forest owners in these four states own more than 8 million hectares of forests, accounting for over 46% of the area's forestland (Butler et al., 2016a). Eight regions, two forested landscapes per state, served as the study area for our analyses: Lower Penobscot River and Saco River watersheds (Maine); Millers and Westfield watersheds (Massachusetts); Cortland-Onondaga counties, and Delaware-Greene counties (New York); and Orleans and Rutland counties (Vermont) (Fig. 1). In consultation with stakeholders, we chose these eight forested landscapes because they all have numerous family forest owners, extensive forest cover, and are experiencing development pressure (Stein et al., 2005). While we initiated discussions using watershed boundaries (Stein et al., 2005), stakeholder/forest extension suggestions resulted in the use of counties to define the regions in New York and Vermont.

Family forest owners in all eight regions have access to a suite of estate planning and conservation tools and preferential tax programs, including those that are the focus of this work. While these eight regions all have extensive forest land cover and family forests, differences in factors such as population and housing levels, development patterns, seasonal housing, median incomes, and recent development activity establish the variation central to our investigation of broad-scale patterns in family forest owner decision-making (see Appendix A for more details). For example, in 2010 housing unit density ranged from nine (Orleans county) to more than 65 housing units per km (Cortland-Onondaga), and seasonal housing units accounted for more than 15% of the housing stock in four (Saco River watershed, Delaware-Greene counties, Orleans county, Rutland county) of the eight regions. These areas also differ in terms of regional land trust and woodland owner organizational activity. For example, regional forest extension staff noted active land trusts in Millers Watershed (Mount Grace Land Trust and North Quabbin Regional Landscape Partnership) and Delaware-Green counties (Watershed Agricultural Council (New York City Watershed)).

2.2. Survey sample, design, and administration

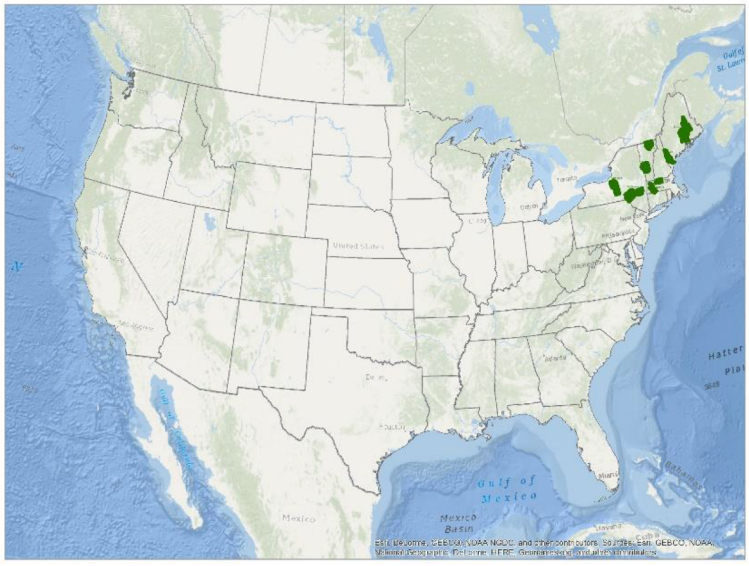
We constructed the survey sample frame based on property information provided by state and municipal agencies. We focused on individuals who own at least four hectares (10 acres) of land and stratified the sample equally above and below 16 ha (40 acres). We segmented owners to ensure representation of larger ownerships who often demonstrate more active forest management and have greater access to programs and other technical assistance tools than landowners with smaller parcels (Butler et al., 2016b). For example, preferential tax programs favoring managed forest lands in our study regions restrict eligibility using minimum acreage thresholds (i.e, 4 ha (10 acres) in Maine and Massachusetts; 20 ha (50 acres) in New York; and 10 ha (25 acres) in Vermont). By randomly selecting ownerships within these two strata, we created a total sample of 2500 ownerships, 625 by state, and 312 or 313 by region.

We used a mail-survey questionnaire to collect information from owners about themselves, their family forests, and their estate planning and conservation actions. Several survey questions prompted owners to summarize their wishes for the future of their family forests and the steps they have taken to support these wishes (refer to Appendix B for details). We administered the mail survey in the fall of 2016 using a modified Dillman tailored design method (Dillman, Smyth, & Christian, 2014).

2.3. Data

To summarize broad-scale patterns in tool use and program participation, we converted survey responses describing the use of wills, trusts, and conservation easements and participation in preferential tax programs to a series of binary indicator variables, with values equal to one indicating use or participation and values equal to zero indicating non-use or non-participation.

For this article, we focused on stated use of wills and trusts that addressed future ownership and/or use of family forest lands. A will is a legally binding document that states how one wants their assets distributed once they have passed away. While this estate planning tool is predominantly used to designate future land ownership, wills can also describe owners' wishes for the future use of their lands. In contrast, a trust is a legal entity that manages assets, including lands, into the future. Though not permanent, trusts outline the future ownership of lands and can be developed to hold and manage assets for decades. Therefore, trusts can be used to help determine the future use of lands, though not permanently. We compared the use of these estate planning tools with participation in preferential tax programs and use of conservation easements. Preferential tax programs offer reduced property taxes in exchange for maintaining particular land uses and, in some instances, meeting particular management (i.e., forest management plans) or sales criteria (i.e., sale of agricultural products) over defined, shorter time periods (e.g., 10-year contracts). Alternatively, a conservation easement is a legal agreement that extinguishes some or all of the development rights of the land forever, but allows other rights such as farming, forestry, and recreation to continue, all while maintaining the private ownership of the land. A conservation easement is a flexible tool that can be placed on all or only designated parts of your land. Just as trusts would be expected to offer longer-term, more formal land conservation options relative to wills, conservation easements provide owners with longer-term, more formal land conservation options than preferential tax programs. However, these more formal instruments can



The eight regions comprising our study area in Northeastern USA are as follows: Lower Penobscot River and Saco Watersheds (Maine); Millers and Westfield Watersheds (Massachusetts); Cortland-Onondaga Counties, and Delaware-Greene Counties (New York); and Orleans and Rutland Counties (Vermont) (Esri 2018).

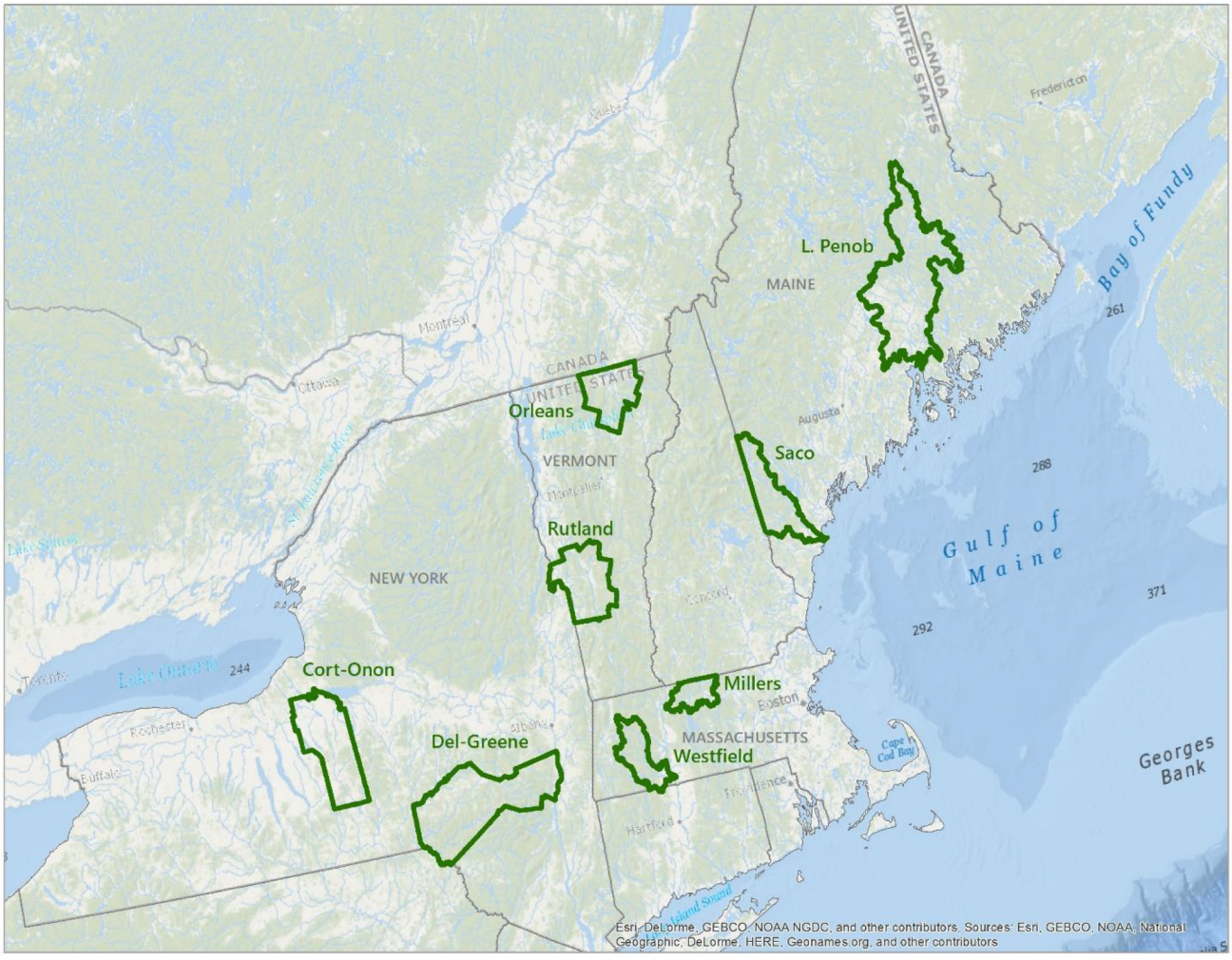


Fig. 1. Eight-region study area – Northeastern USA.

be more costly and complex for owners to put in place. In addition, these longer-term and permanent options reduce the land use options of future owners, which may or may not meet the goals of the current owner.

We expected owners to adopt tools and enroll in programs providing them with welfare gains. Tool adoption and program participation benefit and cost owners, and we assumed that these benefits and costs include financial and non-financial factors. We hypothesized owners

would pursue actions offering them higher net returns and achieving their legacy goals. To represent variation in perceived net returns, we generated three categories of explanatory variables: owner characteristics; land/forest and ownership characteristics; and state, regional, and community measures. We developed specific variables within these categories based on prior research of family forest owners' attitudes and behaviors (see Amacher, Conway, & Sullivan, 2003; Beach et al., 2005; Fischer et al., 2010 for useful reviews) and decisions involving estate planning (Broderick, Hadden, & Heninger, 1994; Catanzaro et al. 2014; Creighton et al., 2016; Gruver et al. 2017; Markowski-Lindsay, Catanzaro, Milman, & Kittredge, 2016), conservation easements (Farmer et al., 2011; Kauneckis & York 2009; Kelly, Germain, & Mack, 2016; Kittredge et al. 2015; Levert et al. 2009; Ma et al., 2012; Mitani & Lindhjem, 2015) and preferential tax programs (Fortney et al., 2011; Hibbard et al., 2003; Kilgore et al., 2016; Kilgore et al. 2007).

To capture *owner characteristics*, we controlled for owner age, income, educational attainment, gender, and legacy goals. We also included variables to distinguish owners with seasonal cabins/camps and primary homes on their wooded lands from owners of lands without such structures. We created proxies for differences in legacy goals using PCA component scores of Likert-scale responses to seven questions summarizing distinct goals related to planning the future of their lands (see Appendix B). These component scores distinguish legacy goals associated with future ownership (i.e., becomes an inheritance, fair treatment of heirs/family; and full range of use options for future owners), financial security (i.e., owner and heirs), and altruism (i.e., protects environment and wildlife; benefits community) (Markowski-Lindsay et al., 2017).

To represent *land/forest and ownership characteristics*, we developed variables describing the size of the land parcel, the number of owners, whether or not the land was acquired via inheritance, and the tenure of ownership.

For the *regional and state measures*, we developed a series of indicator variables, or fixed effects, describing the nesting of individual owners within communities, regions, and states. Using ArcGIS software we created spatial data layers representing the extent of our eight focal regions (US Census Bureau County Boundary File (US Census Bureau, 2016); USGS Watershed Boundary Dataset (U.S. Geological Survey, 2016)) and the communities (i.e., county subdivisions) within these regions. Although we did not know the specific location within the watershed or county of the family forest associated with our survey responses, we did know the community in which these lands were located. Because small counts of respondents within communities prevented us from exploiting community-scale variation, we used regional and state fixed effects to capture contextual factors about family forest landscapes.

2.4. Analysis

2.4.1. Survey administration and design

We assessed non-response bias by comparing results with those from a scoping survey conducted in 2015, which had the same sample design and sample frame (Markowski-Lindsay et al., 2017). We also compared responses of early and late participants and contrasted response rates by study region.

2.4.2. Descriptive statistics and pattern identification

We generated frequency and descriptive statistics and created charts and maps to summarize our study variables. Empirical sample sizes varied across our analyses because we did not impute values for missing fields.

To assess formally broad-scale patterns in owners use of tools and participation in programs, we used chi-square tests, where the null hypothesis was no association between tool use or program participation and state or regional fixed effects. We created the maps (Figs. 1 and 4) using ArcGIS® software and basemaps by Esri (2018).

2.4.3. Discrete regression models of estate planning and conservation behaviors

We estimated a series of binary discrete choice models to scrutinize further the impacts of controlling for region and state. These four logit models of the use of wills, trusts, conservation easements, and enrollment in preferential tax programs represent distinct decisions by family forest owners to influence the future ownership and use of their lands. We opted to estimate and present these distinct, basic models for several reasons. First, while we recognized potential interdependencies across the different behaviors, a quadvariate logit model was beyond the scope of this work. In addition, our empirical sample size and sampling approach did not support a more complex multinomial logit model of unique combinations of tools and programs. Second, our survey data describing these tools and programs is essentially presence/absence information. Information on these distinct tools and program was collected in separate sections of the survey, and these questions did not emphasize combinations of tools. Lastly, we believed these simple binary models were most consistent with our primary research objectives examining the potential importance of regional and state effects and permit straightforward comparisons with prior work on family forest owners. All models share a common base structure, where owners' observable actions, use or nonuse of a tool (y), are explained as a function of observable owner, forest, community, and regional explanatory variables (x) and stochastic random terms accounting for factors unobservable to researchers though observable and relevant to owners. The logit models specify the conditional probability of tool use (prob $(y = 1|x)$) as $F(x'\beta)$, where β are fixed parameters to be estimated, and F represents the logistic cumulative distribution function $\exp(x'\beta)/(1 + \exp(x'\beta))$ (Greene, 2012).

We estimated the logit models by maximum likelihood using Stata software. Prior to estimating the models, we reviewed the distributions of the dependent variables, and assessed the correlation patterns among the proposed explanatory variables to avoid multicollinearity issues. We generated parameter and average marginal effects estimates to describe the correlative relationships between our dependent and explanatory variables. We used the results of the logit models to further pursue our primary research objective. Specifically, for each of the four models of owner actions, we started by estimating a base or conventional specification exclusively incorporating owner and ownership characteristics, and then estimated two additional specifications – one including regional fixed effects and the other including state fixed effects. Measures of global model fit (AIC, Ln Likelihood), likelihood ratio tests, and assessments of the significance of relevant parameter estimates and marginal effects informed our ultimate assessment of the different specifications and broad-scale patterns in owner decisions.

3. Results

3.1. Survey results

Six hundred and thirty-six (of 2500) mailed surveys were returned. One hundred and sixty-two addresses were undeliverable, resulting in a 27% cooperation rate. Extensive testing for non-response bias suggested the bias was low (Markowski-Lindsay et al., 2017). Filters involving forest land-holdings size (10 ha) and location information resulted in the dropping of 96 and 12 observations respectively, resulting in an estimation sample of 528 family forest owners.

Characteristics of the 528 owners in our estimation sample generally corresponded with the characteristics of family forest owners in Maine, Massachusetts, New York, and Vermont. Comparing our estimation sample with state-scale National Woodland Owner Survey

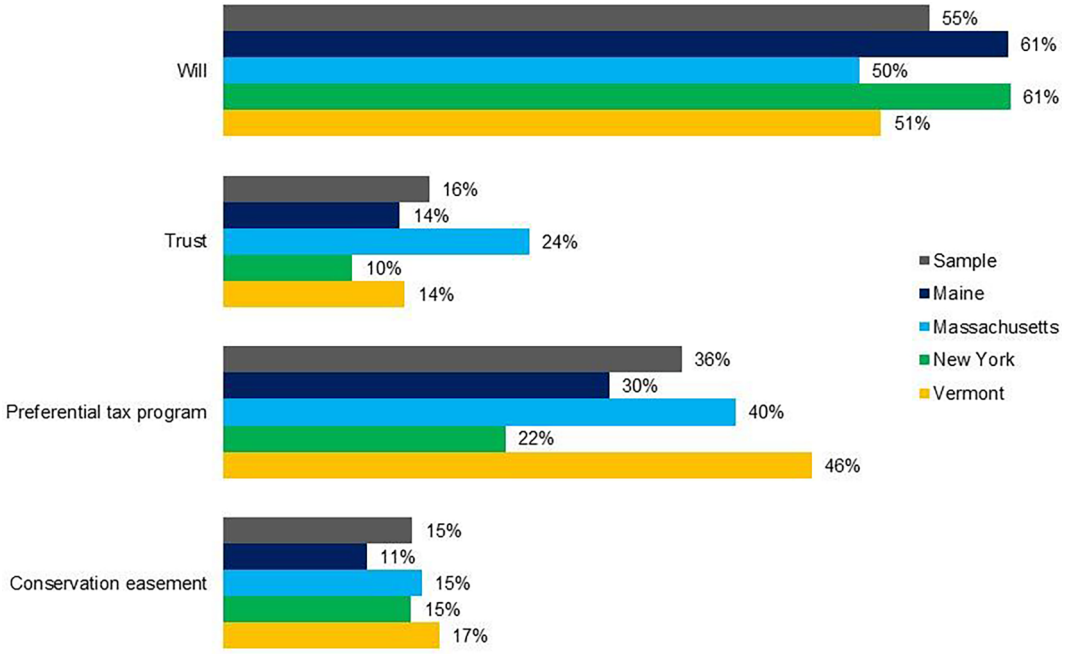


Fig. 2. Actions to designate future ownership and use of family forest lands by state.

(NWOS) data (Butler et al., 2016a) revealed similar demographic (e.g., age, gender) and ownership characteristics (e.g., number of owners, land tenure, inherited). Our respondents, on average, owned more land (i.e., 35 ha (86 acres) of wooded land versus 21 ha (53 acres)) and more frequently held a college degree (63% versus 54%). In addition, although the categories do not allow a direct comparison, owners in our estimation sample had somewhat higher annual income than owners summarized by the state-scale NWOS data.

3.2. Descriptive statistics and pattern analysis

Our estimation sample is dominated by men (72%), individuals with college degrees (63%), and individuals with children (81%) (see Appendix A for details). Respondents varied in age from 27 to 95 years, with an average age of 65 years. On average, respondents in our estimation sample owned 35 ha (86 acres) of wooded land, participated in ownerships consisting of about two owners, and had owned land for 27 years. These owners' lands are somewhat evenly distributed across all four states, with owners of lands in Massachusetts (29%) and Vermont (28%) exceeding those from Maine (22%) and New York (21%). Their lands are also relatively balanced across the eight focal regions, ranging from 10% of the sample (51 owners) in the Cortland-Onondaga region (New York) to 17% (89 owners) of the sample located in the Millers region (Massachusetts). The majority of owners in our estimation sample reported using some form of estate-planning or conservation tool (Fig. 2). Survey respondents consistently indicated higher rates of use of and participation in shorter-term tools and programs (55% with will versus 16% with trust; 36% in preferential tax program versus 15% with easement) (Figs. 2 and 4).

Statistical testing and visualization of the frequency counts of estate-planning and conservation actions by state and region revealed mixed insights about broad-scale usage patterns of these tools (Figs. 2 and 3). Chi-square statistical tests of associations between state as well as region and estate planning and conservation actions hinted at differences in the significance and scale of these broad-scale contextual effects. Assessing state-scale patterns, tests indicated associations by state for use of trusts ($\chi^2 = 11.20$; $p = 0.01$) and participation in preferential tax programs ($\chi^2 = 18.50$; $p = 0.0003$). Similarly, tests suggested regional patterns in the use of trusts ($\chi^2 = 12.00$; $p = 0.10$) and participation in preferential tax programs ($\chi^2 = 27.52$; $p = 0.0003$). Maps of these regional data (Fig. 4) complement these statistical tests, showing, for example, the existing use of trusts in Millers and Westfield, both located in Massachusetts, is notably higher than in other regions (Fig. 4), and current participation in preferential tax programs varies markedly across our eight regions.

3.3. Logit models of estate planning, preferential tax programs, and conservation easements

The four logit models of owner actions all passed global fit tests, and results from these discrete choice models generally corresponded with prior studies of the correlative associations between individual-scale family forest characteristics and owners' decisions (Tables 1—4). Turning to our primary research objective, the logit model results indicate mixed impacts from including the state and regional fixed effects. Reviewing parameter and average marginal effect estimates, state fixed effects controlling for ownerships in Massachusetts (relative to New York respondents) were significant for three of the four behaviors (Tables 1–4). Regional fixed effects (relative to Rutland) demonstrated no consistent patterns across the models of the different behaviors (Tables 1–4). Notably, five of seven regional fixed effects were significant for preferential tax programs (all else equal, owning lands in Saco, Westfield, Delaware-Greene, Lower Penobscot, and Orleans lowered the predicted probability of program participation relative to owning land in Rutland) (Table 4). Further, based on likelihood ratio tests, the alternative specifications improved the fit (relative to the base model) for two of the four owner behaviors (Table 5). Adding the state fixed effects improved the overall performance (relative to the base specification) of the models of trust use and participation in preferential tax programs. In contrast, adding regional fixed effects only improved (relative to the base) the model of preferential tax program participation.

Based on the estimated parameters (Tables 1–4), age, legacy goals, and primary and secondary homes were associated with the predicted

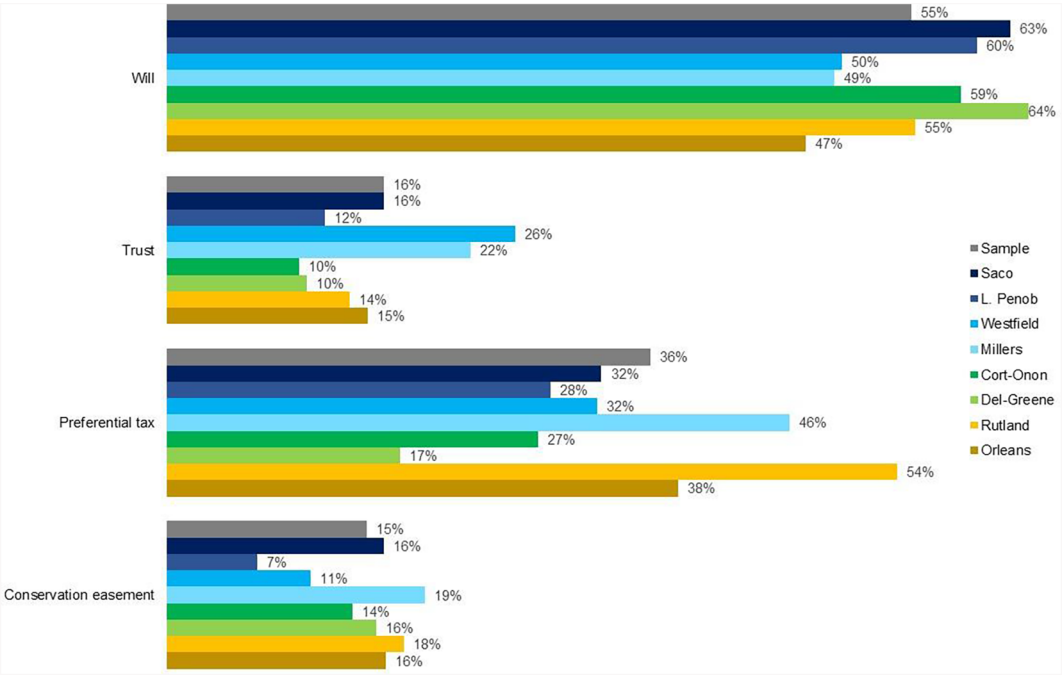


Fig. 3. Actions to designate future ownership and use of family forest lands by region.

probability an individual reported currently using an estate-planning tool, having a conservation easement, or participating in a preferential tax program. Age, legacy goals related to future owners, and altruistic legacy goals were positively associated with the predicted probability of having a will. Similarly, age, legacy goals related to future owners, second and primary residences, and number of owners were consistently and positively associated with the predicted probability of having a trust in place. Altruistic legacy goals and secondary residences were positively associated with the predicted probability of participation in preferential taxation and use of conservation easements. Conversely, financial legacy goals were negatively associated with the predicted likelihood of participation in both conservation programs.

4. Discussion

Looking at diverse estate planning and land conservation tools and preferential tax programs, we detected potential evidence of state- and regional-scale contextual effects. While chi-square tests were suggestive of broad-scale patterns, the discrete choice models allowed for landscape contextual effects to be distinguished from owner and ownership characteristics. Parameter and marginal effect estimates associated with these fixed effects capture broad, unobserved influences such as differences in policies or demographics or locational features (social and biophysical). The benefits of including state and regional fixed effects varied across the models, and these differences raise interesting insights and questions about the underlying mechanisms driving these observed effects. Overall, these results suggest contextual factors matter distinctly for decisions about different tools and could emerge at different temporal and spatial scales.

4.1. Regional patterns in estate-planning and land conservation decisions

Our findings suggest contextual factors, here proxied by state and regional fixed effects, could matter more or less for different types of owner behaviors and are likely to manifest at different spatial scales. Relative to the base specification, the logit model results (Table 5) favored the use of regional fixed effects for preferential tax programs and state fixed effects for trusts and preferential tax programs. State and regional effects were most consistently detected for participation in preferential tax programs, suggesting that, perhaps not surprisingly, when making these decisions landowners are responding to more than just their own demographic and ownership characteristics. One possible explanation of our findings related to the state fixed effects are the well-known differences in preferential tax programs (Kilgore et al., 2016). Finding that, all else equal, owners of forests in our Massachusetts and Vermont study regions were predicted to be more likely to participate than those in the New York regions could reflect, for example, the tighter eligibility and program restrictions in New York (i.e., higher forest land area eligibility, timber harvesting schedules). Similarly, insights conveyed from the regional fixed-effects associated with these programs support the findings of prior works showing variable responses within states to state programs (Fortney et al., 2011; Kittredge et al. 2015; Ma et al., 2014). For example, all else equal, family forest owners in Orleans county, Vermont were predicted to be much less likely to participate than owners in Rutland county, Vermont; possible explanations for this finding include the relatively lower property values in Orleans and the relatively more “independent” spirit of Orleans county’s Northeast Kingdom communities.

Our findings related to estate planning hint at a favoring of trusts related to wills in our Massachusetts study regions (relative to the New York regions); possible explanations for this finding include the relative affluence of these regions. For example, the relatively more affluent landowners in the Massachusetts study regions could have more motivation, confidence, and opportunity to engage in the development of more formal estate planning tools (Kittredge et al., 2015).

Because these observed patterns potentially reflect a history of interactions between decision-making by family forest owners and regional and state programs and institutions, it becomes difficult to pinpoint specific explanations for these trends. Having more information about the timing of specific decisions as well as the timing of policy changes and outreach campaigns would permit closer scrutiny of underlying drivers and the interactions between these diverse factors and land owner decision-making.

4.2. Overall estate-planning and land conservation decisions

We purposely examined a mix of family forest decisions. This set of decisions addressed land ownership and use decisions, involved simple

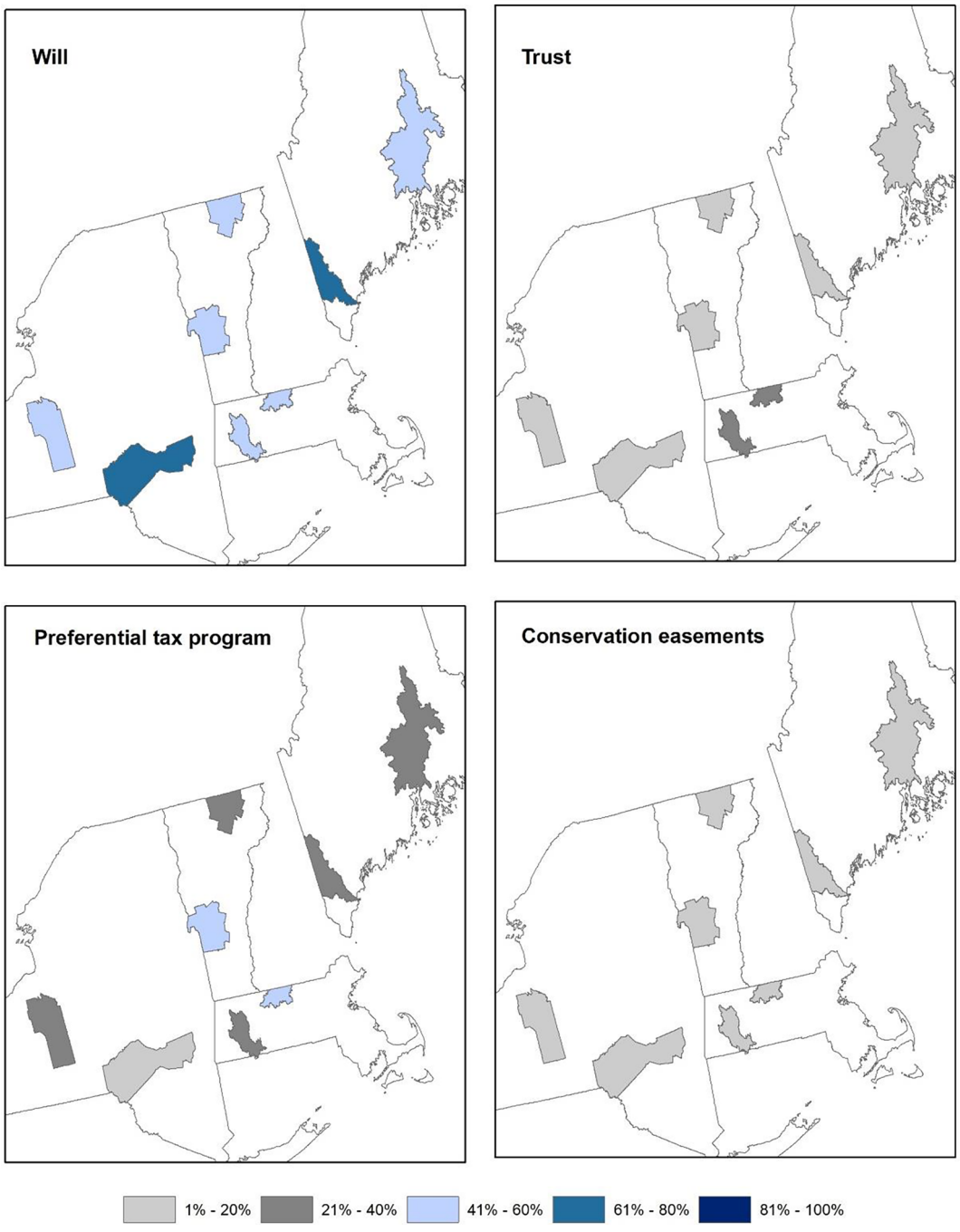


Fig. 4. Mapping actions to designate ownership and use of family forest lands by region.

and more complex estate-planning and conservation tools, and included short- and long-term conservation programs. Above and beyond learning about contextual differences, our results call attention to some fundamental distinctions. First, more family forest owners used tools and participated in programs that were less complex (i.e., wills versus trusts and tax programs versus conservation easements) (Kelly, et al., 2016), and in the case of preferential tax relative to easement programs, shorter duration and more flexible conservation tools (Butler et al., 2016b; Mayer & Tikka, 2006). These tendencies will inevitably shape future land ownership transitions and conversion decisions. Second, while not our primary interest, we observed different associations between owner and ownership characteristics and behaviors associated with estate-planning for and conservation of family forests. These findings are consistent with work that has demonstrated the novelty of legacy decisions (Creighton et al., 2016; Gruver et al., 2017; Markowski-Lindsay et al., 2017) and the urgency of supporting scholarship beyond harvest decisions (Fischer et al., 2010). We are intrigued by the potential of future efforts aimed at linking these two types of decisions, including conservation-based estate planning (Catanzaro et al., 2014).

4.3. Implications for future research of family forest owners

Our results suggest understanding of family forest owner decision-making could be enhanced by greater consideration of factors beyond individual and ownership characteristics. Findings of significant state

Table 1
Results of binary logit models of use of wills by family forest owners (n = 445).

	Base				State fixed effects				Regional fixed effects			
	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value
Intercept	**−7.930**	< 0.001			**−7.628**	0.001			**−8.023**	0.001		
Ln (Age)	**1.843**	0.001	**0.408**	< 0.001	**1.837**	0.001	**0.401**	0.001	**1.858**	0.001	**0.405**	0.001
Female	−0.073	0.751	−0.016	0.751	−0.043	0.854	−0.009	0.855	−0.031	0.893	−0.007	0.893
College Degree	0.005	0.983	0.001	0.983	0.016	0.940	0.004	0.940	0.032	0.882	0.007	0.882
Children	0.453	0.131	0.103	0.135	0.445	0.142	0.099	0.146	0.435	0.153	0.097	0.156
LegGoal_futowner	**0.215**	0.008	**0.048**	0.006	**0.227**	0.005	**0.049**	0.004	**0.236**	0.004	0.051	0.003
LegGoal_altruism	**0.252**	0.005	**0.056**	0.004	**0.252**	0.006	**0.055**	0.004	**0.260**	0.005	0.057	0.003
LegGoal_financial	−0.063	0.511	−0.014	0.510	−0.076	0.433	−0.017	0.432	−0.078	0.419	−0.017	0.418
Second home	0.189	0.498	0.042	0.495	0.183	0.516	0.040	0.513	0.208	0.467	0.045	0.463
Primary residence	−0.043	0.849	−0.009	0.849	−0.048	0.832	−0.011	0.832	−0.047	0.838	−0.010	0.838
Ln (Wooded acreage)	0.096	0.376	0.021	0.375	0.110	0.314	0.024	0.312	0.098	0.376	0.021	0.374
Number of owners	−0.130	0.152	−0.029	0.148	−0.146	0.113	**−0.032**	0.109	−0.144	0.118	−0.031	0.115
Inheritor	0.284	0.295	0.062	0.289	0.336	0.221	0.073	0.213	0.289	0.302	0.063	0.295
ME					−0.148	0.639	−0.031	0.638				
MA					**−0.650**	0.030	**−0.142**	0.026				
VT					−0.358	0.233	−0.077	0.229				
L. Penob									0.138	0.728	0.030	0.728
Saco									0.278	0.511	0.060	0.508
Millers									−0.135	0.718	−0.030	0.718
Westfield									−0.520	0.196	−0.116	0.191
Cort-Onon									0.432	0.309	0.092	0.302
Delaware-Greene									0.265	0.525	0.058	0.523
Orleans									−0.022	0.954	−0.005	0.954
Global LR test	$\lambda^2 = 46.49$ (< 0.001)				$\lambda^2 = 52.10$ (< 0.001)				$\lambda^2 = 53.26$ (< 0.001)			
Goodness of fit	lnL = −281.54; AIC = 589.09; BIC = 642.36				lnL = −278.74; AIC = 589.47; BIC = 655.05				lnL = −278.16; AIC = 596.32; BIC = 678.28			

*Left-out category for state and regional indicator variables are New York (NY) and Rutland respectively. Bolded estimates significance of at least 0.10.

and regional effects (beyond variation in owner and ownership characteristics) suggest other things in the landscape matter and are potentially driving differences in behaviors and forest outcomes (Beach et al., 2005; Canadas & Novais, 2014). This inference aligns generally with prior studies that consider more than individual family forest ownerships and emphasize multi-scale processes and interactions (e.g., Aguilar, Cai, & Butler, 2017; Amacher et al., 2003; BenDor, Shoemaker, Thill, Dorning, & Meentemeyer, 2014; Huff, Leahy, Kittredge, Noblet, & Weiskittel, 2017; Warren, Ryan, Lerman, & Tooke, 2011). When these contextual variables are omitted from regression and other types of analyses, results are prone to bias and likely to provide incomplete assessments of decision-making.

While insightful, our exploratory approach has several limitations. Regional and spatial analyses were not a primary objective of our original research project. Accordingly, we did not design our sample frame to obtain large numbers of respondents from specific regions or communities or collect information about the specific location of the owners' family forests. As we conducted this exploratory research, analyses were excluded (e.g., hot or cold spot analysis by community; hierarchical modeling/random effects; non-binary discrete choice models) or limited (e.g., small sample size by region) by this original sampling decision. We opted not to impute values for missing survey responses and recognize this choice may have induced sample selection bias. We included measures of self-reported legacy goals in our models and acknowledge the likely advantages of treating these goals as endogenous. We also recognize the limitations of estimating a series of binary choice models and acknowledge that a portfolio approach or non-binary discrete choice model that modeled multiple decisions simultaneously could add value. While these analyses were beyond the scope of this analysis, we hope our frank discussion of our limitations guides future work. In addition, we remain hopeful that our exploratory research calls attention to the need for more emphasis of and reflection on contextual differences and unobserved heterogeneity.

Future research focused on systematic collection of information about contextual effects in distinct landscapes could advance our understanding of family forest-owners as drivers of landscape change. Such efforts will benefit individual studies as well as meta-analyses and coupled systems models, improving the potential for robust generalization of findings across areas and the detailed consideration of owner-landscape feedbacks (BenDor et al., 2014; Ma et al., 2014; Morzillo et al., 2015). We are excited by the potential of more advanced hierarchical and random effect modeling approaches to represent heterogeneity in decision-making at multiple scales. Similarly, we encourage future researchers to collect and prioritize spatial–temporal data and are excited by opportunities to combine longitudinal data on owners and spatial data on biophysical and social landscape contexts. We encourage researchers collecting information from owners about program participation and tool adoption to gather details about the timing and location of specific decisions and the locations of lands impacted by such decisions. Improved temporal and spatial information are critical to improving insights about owner decisions, landscape change, and owner-landscape feedbacks. Lastly, in making sense of our findings, we acknowledged the importance of past and ongoing engagement efforts with family forest owners as drivers of the observed patterns in owner behavior. Future research using advanced program evaluation techniques (Ferraro & Hanauer, 2014) could simultaneously improve knowledge of owner decision-making and the effectiveness of different engagement efforts, policies, and programs aimed at influencing these decisions.

4.4. Implications for future engagement with family forest owners

Our findings suggest characteristics of states and regions beyond owner and ownership characteristics influence family forest owner decision-making. As practitioners engage with owners about different planning and conservation tools, they affect and are affected by these

Table 2
Results of binary logit models of use of trusts by family forest owners (n = 445).

	Base				State fixed effects				Regional fixed effects			
	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value
Intercept	**−18.951**	< 0.001			**−19.796**	< 0.001			**−19.387**	< 0.001		
Ln (Age)	**3.549**	< 0.001	**0.373**	< 0.001	**3.607**	< 0.001	**0.370**	< 0.001	**3.622**	< 0.001	0.369	< 0.001
Female	0.260	0.441	0.028	0.454	0.238	0.489	0.025	0.499	0.226	0.514	0.024	0.524
College Degree	0.197	0.540	0.020	0.535	0.140	0.667	0.014	0.665	0.110	0.740	0.011	0.738
Children	−0.147	0.761	−0.016	0.767	−0.089	0.857	−0.009	0.860	−0.077	0.876	−0.008	0.878
LegGoal_futowner	**0.196**	0.100	**0.021**	0.098	0.175	0.149	0.018	0.146	0.183	0.135	0.019	0.132
LegGoal_altruism	**−0.032**	0.801	−0.003	0.801	−0.023	0.859	−0.002	0.859	−0.006	0.964	−0.001	0.964
LegGoal_financial	**−0.061**	0.658	−0.006	0.658	−0.036	0.794	−0.004	0.794	−0.045	0.753	−0.005	0.753
Second home	0.744	0.031	**0.088**	0.052	0.816	0.023	**0.095**	0.040	**0.922**	0.012	0.108	0.025
Primary residence	−0.409	0.214	−0.043	0.217	−0.425	0.207	−0.044	0.209	−0.418	0.223	−0.043	0.226
Ln (Wooded acreage)	**0.428**	0.004	**0.045**	0.003	**0.402**	0.008	**0.041**	0.007	**0.413**	0.007	**0.042**	0.006
Number of owners	**0.174**	0.106	**0.018**	0.103	**0.204**	0.059	**0.021**	0.056	0.204	0.059	**0.021**	0.056
Inheritor	0.267	0.459	0.029	0.477	0.106	0.776	0.011	0.779	0.130	0.735	0.014	0.740
ME					0.471	0.376	0.038	0.370				
MA					**1.202**	0.012	**0.123**	0.006				
VT					0.565	0.251	0.048	0.231				
L. Penob									−0.353	0.582	−0.031	0.576
Saco									0.212	0.737	0.022	0.740
Millers									0.629	0.228	0.073	0.218
Westfield									0.693	0.214	0.082	0.216
Cort-Onon									0.036	0.960	0.004	0.960
Delaware-Greene									−1.013	0.149	−0.073	0.130
Orleans									−0.009	0.987	−0.001	0.987
Global LR test	$\chi^2 = 56.73$ (< 0.001)				$\chi^2 = 64.53$ (< 0.001)				$\chi^2 = 66.80$ (< 0.001)			
Goodness of fit	lnL = −154.90; AIC = 335.81; BIC = 389.08				lnL = −151.00; AIC = 334.00; BIC = 399.58				lnL = −149.87; AIC = 339.73; BIC = 421.69			

*Left-out category for state and regional indicator variables are New York (NY) and Rutland respectively. Bolded estimates of significance of at least 0.10.

Table 3
Results of binary logit models of participation in preferential tax programs by family forest owners (n = 432).

	Base				State fixed effects				Regional fixed effects			
	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value
Intercept	−3.642	0.137			**−4.359**	0.080			−3.473	0.168		
Ln (Age)	−0.448	0.447	−0.081	0.446	−0.389	0.516	−0.068	0.515	−0.346	0.570	−0.059	0.570
Female	−0.043	0.869	−0.008	0.869	−0.101	0.704	−0.018	0.703	−0.064	0.814	−0.011	0.813
College Degree	0.135	0.577	0.024	0.577	0.129	0.599	0.023	0.599	0.135	0.595	0.023	0.595
Children	0.199	0.569	0.035	0.564	0.251	0.486	0.044	0.478	0.214	0.559	0.036	0.553
LegGoal_futowner	0.026	0.774	0.005	0.774	0.013	0.889	0.002	0.889	0.040	0.671	0.007	0.671
LegGoal_altruism	**0.330**	0.001	**0.059**	0.001	**0.352**	0.001	**0.062**	< 0.001	**0.382**	< 0.001	**0.065**	< 0.001
LegGoal_financial	**−0.209**	0.054	**−0.038**	0.051	**−0.201**	0.069	**−0.035**	0.066	**−0.225**	0.047	**−0.038**	0.044
Second home	−0.092	0.769	−0.017	0.767	−0.106	0.741	−0.019	0.739	0.010	0.975	0.002	0.975
Primary residence	0.392	0.124	0.070	0.116	0.387	0.136	0.067	0.128	0.391	0.142	0.066	0.134
Ln (Wooded acreage)	**1.091**	< 0.001	**0.197**	< 0.001	**1.063**	< 0.001	**0.187**	< 0.001	**1.091**	< 0.001	**0.186**	< 0.001
Number of owners	0.043	0.687	0.008	0.687	0.053	0.628	0.009	0.628	0.064	0.570	0.011	0.570
Inheritor	**0.608**	0.036	**0.115**	0.041	**0.533**	0.075	**0.098**	0.083	0.398	0.204	0.070	0.215
ME					0.293	0.432	0.049	0.431				
MA					**0.933**	0.007	**0.165**	0.005				
VT					**0.764**	0.025	**0.133**	0.023				
L. Penob									**−0.937**	0.044	**−0.171**	0.039
Saco									**−0.827**	0.079	**−0.153**	0.072
Millers									0.117	0.773	0.022	0.773
Westfield									**−0.793**	0.085	**−0.147**	0.080
Cort-Onon									−0.707	0.126	−0.132	0.122
Delaware-Greene									**−1.735**	0.001	**−0.290**	< 0.001
Orleans									**−0.958**	0.025	**−0.175**	0.021
Global LR test	χ^2 = 105.9 (< 0.001)				χ^2 = 115.62 (< 0.001)				χ^2 = 128.16 (< 0.001)			
Goodness of fit	lnL = −232.33; AIC = 490.66; BIC = 543.54				lnL = −227.47; AIC = 486.94; BIC = 552.04				lnL = −221.20; AIC = 482.40; BIC = 563.77			

*Left-out category for state and regional indicator variables are New York (NY) and Rutland respectively. Bolded estimates of significance of at least 0.10.

Table 4
Results of binary logit models of use of conservation easements by family forest owners (n = 453).

	Base				State fixed effects				Regional fixed effects			
	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value	β	p-value	Marginal	p-value
Intercept	**−8.570**	0.011			**−8.368**	0.014			**−8.490**	0.014		
Ln (Age)	0.929	0.248	0.107	0.248	0.929	0.251	0.106	0.250	0.939	0.251	0.106	0.250
Female	0.031	0.923	0.004	0.923	0.053	0.871	0.006	0.872	0.046	0.887	0.005	0.888
College Degree	−0.398	0.180	−0.047	0.190	−0.421	0.158	−0.050	0.167	−0.418	0.167	−0.049	0.176
Children	**0.884**	0.061	**0.084**	0.021	**0.887**	0.060	**0.084**	0.020	**0.861**	0.07	**0.082**	0.026
LegGoal_futowner	−0.169	0.117	−0.020	0.116	−0.162	0.131	−0.019	0.130	−0.150	0.17	−0.017	0.168
LegGoal_altruism	**0.387**	0.003	**0.045**	0.002	**0.396**	0.002	**0.045**	0.002	**0.422**	0.001	**0.048**	0.001
LegGoal_financial	**−0.315**	0.022	**−0.036**	0.021	**−0.309**	0.026	**−0.035**	0.025	**−0.316**	0.023	**−0.036**	0.021
Second home	−0.164	0.672	−0.018	0.663	−0.209	0.592	−0.023	0.579	−0.194	0.628	−0.021	0.616
Primary residence	0.426	0.173	0.049	0.165	0.398	0.206	0.045	0.198	0.456	0.153	0.051	0.144
Ln (Wooded acreage)	**0.488**	0.001	**0.056**	0.001	**0.507**	0.001	**0.058**	0.001	**0.500**	0.001	**0.057**	0.001
Number of owners	0.082	0.456	0.010	0.455	0.071	0.526	0.008	0.526	0.076	0.501	0.009	0.501
Inheritor	−0.071	0.845	−0.008	0.843	−0.107	0.771	−0.012	0.767	−0.257	0.499	−0.028	0.477
ME					−0.694	0.128	−0.074	0.124				
MA					−0.083	0.832	−0.011	0.833				
VT					−0.212	0.586	−0.026	0.589				
L. Penob									−0.977	0.13	**−0.090**	0.105
Saco									−0.240	0.679	−0.028	0.674
Millers									0.337	0.475	0.045	0.473
Westfield									−0.595	0.337	−0.061	0.315
Cort-Onon									0.031	0.956	0.004	0.956
Delaware-Greene									0.161	0.761	0.021	0.762
Orleans									−0.229	0.655	−0.026	0.654
Global LR test	χ^2 = 39.43 (< 0.001)				χ^2 = 42.32 (< 0.001)				χ^2 = 46.2 (< 0.001)			
Goodness of fit	lnL = −171.86; AIC = 369.72; BIC = 423.22				lnL = −170.41; AIC = 372.83; BIC = 438.68				lnL = −168.48; AIC = 376.95; BIC = 459.27			

*Left-out category for state and regional indicator variables are New York (NY) and Rutland respectively. Bolded estimates of significance of at least 0.10.

Table 5
Comparing performance of models of estate planning and conservation behaviors.

	Base	State fixed effects	Regional fixed effects
Wills			
lnL	−281.54	−278.74	−278.16
AIC	598.09	589.48	596.32
n	445	445	445
LR test (versus Base)		5.61	6.77
prob > χ2		0.133	0.45
Trusts			
lnL	−154.90	−151.00	−149.87
AIC	335.81	334.01	339.73
n	445	445	445
LR test (versus Base)		**7.80**	10.08
prob > χ2		**0.05**	0.18
Preferential tax programs			
lnL	−232.33	−227.47	−221.20
AIC	490.66	486.94	482.40
n	432	432	432
LR test (versus Base)		**9.71**	**22.26**
prob > χ2		**0.02**	< **0.01**
Conservation easements			
lnL	−171.86	−170.41	−168.48
AIC	369.715	372.829	376.952
n	453	453	453
LR test (versus Base)		2.89	6.76
prob > χ2		0.41	0.45

contextual factors. Tailored and distributed estate planning and conservation efforts with local partners who understand the specific areas could outperform uniform or one-size-fits-all strategies. Our results also support continued emphasis of owner and ownership characteristics when engaging with family forest owners. The significance of associations detected between future land and ownership legacy goals and estate-planning and conservation behaviors hints at the need for additional information beyond forest management objectives or goals. Practitioners in the field could benefit from the development of tools to assess such goals rapidly and easily and improve discussions with owners about estate planning and conservation tools (Markowski-Lindsay et al., 2017).

5. Conclusions

Family forest owner decisions regarding the future ownership and use of their lands have and will continue to drive landscape change by accelerating or attenuating various forms of change and disturbance. Improving knowledge and understanding of how these decisions are made in different landscape settings will broadly benefit private and public decision-makers. Greater consideration of feedback effects between landscape change, landscape context, and owners' decisions will strengthen transfer of insights across landscapes and better support the design and evaluation of future engagement and programs aimed at family forest owners. As this research helps to demonstrate, each family forest owner has their own unique set of circumstances that is influenced by social and physical factors at multiple scales. Future outreach and policy work to support these decisions that is tailored to distinct contexts and exhibits flexibility could prove critical to responding to the profound societal challenge of simultaneously helping family forest owners achieve their personal goals and maintaining the numerous societal services provided by forest systems.

Acknowledgements

This research is based on work supported by the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) (Award Number 2015-68006-23110, Maine Agricultural & Forest Experiment Station projects ME0-L-7-00524-13 and ME0-M-7-00500-12, and University of Massachusetts MacIntire-Stennis Grant #17). We thank Nancy E. Bockstael, Dave Kittredge, and three anonymous reviewers for their assistance.

Appendix A. Characteristics of eight study regions and estimation sample

Table A1.

Table A1
Land, housing, and population characteristics of eight study regions in the northeastern United States.

	Maine		Massachusetts		New York		Vermont	
	L. Penob	Saco	Millers	Westfield	Cort-Onon	Del-Greene	Orleans	Rutland
Landscape area (km^2)	6163.90	2153.72	802.40	1339.03	3385.46	5504.94	1867.82	2446.98
Forest cover (%; 2011)	68.16	70.72	71.34	76.07	42.71	77.51	68.58	74.18
Family forest ownership (%; 2014)	39.50	64.84	32.79	37.84	32.16	44.25	49.31	31.74
Impervious surface (%; 2011)	1.31	1.35	2.93	2.35	4.14	0.55	1.00	1.23
Housing built after 2000 (%)	14.14	15.27	7.26	6.80	6.99	11.15	14.81	7.21
Housing units (2010)	69,295	33,487	27,057	40,304	222,934	60,432	16,162	33,768
Housing unit density (hu/km^2;2010)	11.83	16.79	34.79	30.67	67.39	11.17	9.00	14.02
Median housing value ($; 2010)	125,956	195,131	211,465	237,086	109,750	153,600	149,200	172,100
Population (2010)	147,248	64,584	61,699	93,669	516,362	97,201	27,231	61,642
Distance to population center (km)	27	35	28	18	23	66	84	55
Distance to wood products site (km)	14	30	27	82	108	31	61	43
Median household income ($;2010)	45,834	52,914	58,097	64,645	50,545	45,272	41,618	48,968
Median age (years; 2010)	42.97	43.19	42.55	45.45	37.20	44.70	43.70	44.30
College degree (%; 2010)	25.55	22.14	19.37	27.45	32.05	18.99	20.04	26.91
Seasonal housing units (%; 2010)	7.49	19.07	3.15	4.08	1.47	26.59	24.45	17.14

Sources: Hewes, Butler, & Liknes, 2017; Homer et al., 2015; Manson, Schroeder, Van Riper, & Ruggles, 2017; Prestemon, Pye, Barbour, Smith, G.R., Ince, & Steppleton, 2009; U.S. Geological Survey, 2016.

Table A2.

Table A2
Family forest owner analysis - estimation sample descriptive statistics.

	Units	N	Mean	Std Dev
Owner characteristics				
Will	1/0	509	0.57	0.50
Trust	1/0	508	0.17	0.37
Cons. Easement	1/0	520	0.15	0.36
Preferential tax	1/0	495	0.38	0.49
Age	years	498	65.10	11.70
Female	1/0	528	0.28	0.45
Income (< 35 K)	1/0	474	0.16	0.37
Income (35–65 K)	1/0	474	0.22	0.41
Income (65–100 K)	1/0	474	0.25	0.43
Income(> =100 K)	1/0	474	0.38	0.48
College Degree	1/0	505	0.63	0.48
Children	1/0	528	0.81	0.40
LegGoal_futowner	PCA score	506	0.01	1.53
LegGoal_altruism	PCA score	506	−0.03	1.20
LegGoal_financial	PCA score	506	0.03	1.21
Second home	1/0	511	0.23	0.42
Primary residence	1/0	524	0.55	0.50
Land/ownership characteristics				
Wooded acreage	acres	528	86.08	202.81
Number of owners	count	517	1.94	1.13
Inheritor	1/0	525	0.19	0.39
Ownership tenure	years	517	27.13	14.88
State, region, and community measures				
ME	1/0	528	0.22	0.41
MA	1/0	528	0.29	0.46
NY	1/0	528	0.21	0.41
VT	1/0	528	0.28	0.45
L. Penob	1/0	528	0.11	0.32
Saco	1/0	528	0.11	0.31
Millers	1/0	528	0.17	0.37
Westfield	1/0	528	0.13	0.33
Cort-Onon	1/0	528	0.10	0.30
Delaware-Greene	1/0	528	0.11	0.31
Orleans	1/0	528	0.14	0.35
Rutland	1/0	528	0.14	0.35

*Full sample (n = 528); N indicates number of observations with valid responses.

Appendix B. Questions used to inform dependent variables

Choices Made Concerning Your Land

There are many ways to achieve your goals for the future ownership and use of your land after you no longer own it. This section asks if you have already made some of these choices.

16. A **will** is a legal document you can use to specify the future ownership of your land; it is carried out upon your passing. A will may also describe your wishes for future uses of your land.

a. Do you have a will?

YesNo

b. Does your will include who will own your land after you?

YesNoI don't have a will

c. Does your will include your wishes for how you want the land used in the future?

YesNoI don't have a will

18. A **trust** is a document that creates a legal entity for your assets that may include your land. It specifies the future ownership of your assets and may specify future uses of your land.

a. Do you have a trust?

YesNo

b. Does your trust include who will own your land after you?

YesNoI don't have a trust

c. Does your trust include your wishes for how you want the land used in the future?

YesNoI don't have a trust

20. A **conservation easement/restriction** is a legal agreement that removes some or all of the development rights of the land forever, but can allow other rights or uses of the land such as farming, forestry, and recreation to continue, all while maintaining ownership of the land privately by you or by others. trust is a document that creates a legal entity for your assets that may include your land. It specifies the future ownership of your assets and may specify future uses of your land.

Has a conservation easement or restriction been placed on any part of your land? (check all that apply)

Yes: by me

Yes: by previous owner

No

I don't know

22. Some state and local governments have **current use property tax programs** that defer, reduce, or eliminate property tax for wooded or agricultural land (Chapter 61, Use Value Appraisal, Current Use, Tree Growth Tax Program, or 480-a Forest Tax Laws).

Is any of your land currently enrolled in one of these programs?

Yes

No

I don't know

References

Aguilar, F. X., Cai, Z., & Butler, B. (2017). Proximal association of land management preferences: Evidence from family forest owners. *PLoS One, 12*(1), e0169667. https://doi.org/10.1371/journal.pone.0169667.

Alig, R. J., Kline, J. D., & Lichtenstein, M. (2004). Urbanization on the US landscape: Looking ahead in the 21st century. *Landscape and Urban Planning, 69*(2), 219–234. https://doi.org/10.1016/j.landurbplan.2003.07.004.

Amacher, G. S., Conway, M. C., & Sullivan, J. (2003). Econometric analyses of non-industrial forest landowners: Is there anything left to study? *Journal of Forest Economics, 9*, 137–164. https://doi.org/10.1078/1104-6899-00028.

Beach, R., Pattanayak, S. K., Yang, J. C., Murray, B. C., & Abt, R. C. (2005). Econometric studies of non-industrial private forest management: A review and synthesis. *Forest Policy and Economics, 7*(3), 261–281. https://doi.org/10.1016/S1389-9341(03)00065-0.

BenDor, T., Shoemaker, D. A., Thill, J. C., Dorning, M. A., & Meentemeyer, R. K. (2014). A mixed-methods analysis of social-ecological feedbacks between urbanization and forest persistence. *Ecology and Society, 19*(3), 3. https://doi.org/10.5751/ES-06508-190303.

Broderick, S. H., Hadden, K. P., & Heninger, B. (1994). The next generation's forest: Woodland owners' attitudes toward estate planning and land preservation in Connecticut. *Northern Journal of Applied Forestry, 11*(2), 47–52.

Butler, B. J., Hewes, J. H., Dickinson, B., Andrejczyk, K., Butler, S. M., & Markowski-Lindsay, M. (2016a). *USDA Forest Service National Woodland Owner Survey: National, regional, and state statistics for family forest and woodland ownerships with 10+ acres, 2011-2013 (No. Res. Bull. NRS-99).* Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

Butler, B. J., Hewes, J. H., Dickinson, B. J., Andrejczyk, K., Butler, S. M., & Markowski-Lindsay, M. (2016b). Family forest ownerships of the United States, 2013: Findings from the U.S. Forest Service's National Woodland Owner Survey. *Journal of Forestry, 114*, 638–647. https://doi.org/10.5849/jof.15-099.

Canadas, M. J., & Novais, A. (2014). Bringing local socioeconomic context to the analysis of forest owners' management. *Land Use Policy, 41*, 397–407. https://doi.org/10.1016/j.landusepol.2014.06.017.

Catanzaro, P., Markowski-Lindsay, M., Milman, A., & Kittredge, D. (2014). Assisting family forest owners with conservation-based estate planning: A preliminary analysis. *Journal of Extencion, 52*(2), 2FEA9.

Creighton, J., Blatner, K. A., & Carroll, M. S. (2016). For the Love of the Land: Generational Land Transfer and the Future of Family Forests in Western Washington State, USA. *Small-Scale Forestry, 15*(1), https://doi.org/10.1007/s11842-015-9301-2.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4th ed.). Hoboken, NJ: Wiley & Sons.

Esri. (2018). World Ocean [basemap]. Scale not given. World Ocean Basemap and Reference. April 11, 2018. http://www.arcgis.com/home/item.html?id=48b8cec7ebf04b5fbdcaf70d09daff21. (June 6 2018).

Farmer, J. R., Knapp, D., Meretsky, V. J., Chancellor, C., & Fischer, B. C. (2011). Motivations influencing the adoption of conservation easements. *Conservation Biology, 25*, 827–834. https://doi.org/10.1111/j.1523-1739.2011.01686.x.

Ferraro, P. J., & Hanauer, M. M. (2014). Advances in measuring the environmental and social impacts of environmental programs. *Annual Review of Environment and Resources, 39*(1), 495–517. https://doi.org/10.1146/annurev-environ-101813-013230.

Fischer, A. P., Bliss, J., Ingemarson, F., Lidestav, G., & Lönnstedt, L. (2010). From the small woodland problem to ecosocial systems: the evolution of social research on small-scale forestry in Sweden and the USA. *Scandinavian Journal of Forest Research, 25*(4), 390–398. https://doi.org/10.1080/02827581.2010.498386.

Fischer, A. P., & Charnley, S. (2012). Risk and cooperation: Managing hazardous fuel in mixed ownership landscapes. *Environmental Management, 49*, 1192. https://doi.org/10.1007/s00267-012-9848-z.

Fortney, J., Arano, K. G., & Jacobson, M. (2011). An evaluation of West Virginia's managed timberland tax incentive program. *Forest Policy and Economics, 13*(1), 69–78. https://doi.org/10.1016/j.forpol.2010.08.002.

Greene, W. H. (2012). *Econometric analysis* (7th ed.). Boston, MA: Prentice Hall.

Gruver, J. B., Metcalf, A. L., Muth, A. B., Finley, J. C., & Luloff, A. E. (2017). Making decisions about forestland succession: Perspectives from Pennsylvania's private forest landowners. *Society & Natural Resources, 30*, 47–62. https://doi.org/10.1080/08941920.2016.1180728.

Hewes, J. H., Butler, B. J., & Liknes, G. C. (2017). *Forest ownership in the conterminous United States circa 2014: distribution of seven ownership types – Geospatial dataset.* Fort

Collins, CO: Forest Service Research Data Archive.
Hibbard, C. M., Kilgore, M. A., & Ellefson, P. V. (2003). Property taxation of private forests in the United States: A national review. *Journal of Forestry, 101*(3), 44–49.
Homer, C. G., Dewitz, J. A., Yang, L., Jin, S., Danielson, P., Xian, G., ... Megown, K. (2015). Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing, 81*(5), 345–354.
Huff, E. S., Leahy, J. E., Kittredge, D. B., Noblet, C., & Weiskittel, A. R. (2017). Psychological distance of timber harvesting for private woodland owners. *Forest Policy and Economics, 81*, 48–56. https://doi.org/10.1016/j.forpol.2017.04.007.
Jarrett, A., Gan, J., Johnson, C., & Munn, I. A. (2009). Landowner awareness and adoption of wildfire programs in the southern United States. *Journal of Forestry, 107*(3), 113–118.
Kauneckis, D., & York, A. M. (2009). An empirical evaluation of private landowner participation in voluntary forest conservation programs. *Environmental Management, 44*(3), 468–484. https://doi.org/10.1007/s00267-009-9327-3.
Kelly, M. C., Germain, R. H., & Mack, S. A. (2015). Family forest owner preferences for forest conservation programs: A New York case study. *Forest Science, 61*(3), 597–603. https://doi.org/10.5849/forsci.13-120.
Kelly, M. C., Germain, R. H., & Mack, S. A. (2016). Forest conservation programs and the landowners who prefer them: Profiling family forest owners in the New York City watershed. *Land Use Policy, 50*, 17–28. https://doi.org/10.1016/j.landusepol.2015.08.026.
Kilgore, M. A., Ellefson, P. V., Funk, T. J., & Frey, G. E. (2016). *State property tax programs in the United States: A review and evaluation of incentives for promoting ecosystem services from private forestland, Staff Paper 242.* St. Paul, MN: Department of Forest Resources, University of Minnesota.
Kilgore, M. A., Greene, J. L., Jacobson, M. G., Straka, T. J., & Daniels, S. E. (2007). The influence of financial incentive programs in promoting sustainable forestry on the nation's family forests. *Journal of Forestry, 105*(4), 184–191.
Kittredge, D. B., Gianotti, A. G., Hutrya, L., Foster, D. R., & Getson, J. M. (2015). Landowner conservation awareness across rural-to-urban gradients in Massachusetts. *Biological Conservation, 184*, 79–89. https://doi.org/10.1016/j.biocon.2015.01.001.
LeVert, M., Stevens, T., & Kittredge, D. (2009). Willingness to sell conservation easements: A case study of private forestland owners in Southern New England. *Journal of Forest Economics, 15*(4), 261–275. https://doi.org/10.1016/j.jfe.2009.02.001.
Ma, Z., Butler, B. J., Catanzaro, P. F., Greene, J. L., Hewes, J. H., Kilgore, M. A., ... Tyrrell, M. (2014). The effectiveness of state preferential property tax programs in conserving forests: Comparisons, measurements, and challenges. *Land Use Policy, 36*, 492–499. https://doi.org/10.1016/j.landusepol.2013.09.016.
Ma, Z., Butler, B. J., Kittredge, D. B., & Catanzaro, P. (2012). Factors associated with landowner involvement in forest conservation programs in the U.S.: Implications for policy design and outreach. *Land Use Policy, 29*, 53–61. https://doi.org/10.1016/j.landusepol.2011.05.004.
Ma, Z., Clarke, M., & Church, S. P. (2018). Insights into individual and cooperative invasive plant management on family forestlands. *Land Use Policy, 75*, 682–693. https://doi.org/10.1016/j.landusepol.2018.02.010.
Manson, S., Schroeder, J., Van Riper, D., & Ruggles, S. (2017). *IPUMS national historical geographic information system: Version 12.0 [Database].* Minneapolis: University of Minnesota.
Markowski-Lindsay, M., Catanzaro, P., Bell, K., Kittredge, D., Leahy, J., Butler, B., ... Sisock, M. (2017). Estate planning as a forest stewardship tool: a study of family land ownerships in the northeastern U.S. *Forest Policy and Economics, 83*, 36–44. https://doi.org/10.1016/j.forpol.2017.06.004.
Markowski-Lindsay, M., Catanzaro, P., Milman, A., & Kittredge, D. (2016). Understanding family forest land future ownership and use: Exploring conservation bequest motivations. *Small-Scale Forestry,* 1–16. https://doi.org/10.1007/s11842-015-9320-z.
Mayer, A. L., & Tikka, P. M. (2006). Biodiversity conservation incentive programs for privately owned forests. *Environmental Science & Policy, 9*(7), 614–625. https://doi.org/10.1016/j.envsci.2006.07.004.
Mitani, Y., & Lindhjem, H. (2015). Forest owners' participation in voluntary biodiversity conservation: What does it take to forgo forestry for eternity? *Land Economy, 91*(2), 235–251. https://doi.org/10.3368/le.91.2.23.
Morzillo, A. T., Colocousis, C., Munroe, D., Bell, K. P., Martinuzzi, S., Van Berkel, D. B., ... McGill, B. (2015). Forests in the middle: Interactions between drivers of change and place-based characteristics in rural forest communities. *Journal of Rural Studies, 42*(December), 79–90. https://doi.org/10.1016/j.jrurstud.2015.09.007.
Mundell, J., Taff, S. J., Kilgore, M. A., & Snyder, S. A. (2010). Using real estate records to assess forest land parcelization and development: A Minnesota case study. *Landscape and Urban Planning, 94*(2), 71–76. https://doi.org/10.1016/j.landurbplan.2009.08.001.
Prestemon, J., Pye, J., Barbour, J., Smith, G.R., Ince, P., Steppleton, C. & Xu, W. (2009). 2005 U.S. Wood-Using Mill Locations. https://www.srs.fs.usda.gov/econ/data/mills/ (Accessed April 15 2016).
Silver, E., Leahy, J., Kittredge, D., Noblet, C., & Weiskittel, A. (2015). An evidence-based review of timber harvesting: Behavior among private woodland owners. *Journal of Forestry, 113*(5), 490–499.
Song, N., Aguilar, F. X., & Butler, B. J. (2014). Conservation easements and management by family forest owners: A propensity score matching approach with multi-imputations of survey data. *Forest Science, 60*(2), 298–307. https://doi.org/10.5849/forsci.12-107.
Stein, S. M., McRoberts, R. E., Alig, R. J., Nelson, M. D., Theobald, D. M., Eley, M., ... Carr, M. (2005). *Forests on the edge: Housing development on America's private forests (No. Gen. Tech. Rep. PNW-GTR-636).* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
U.S. Geological Survey. (2016). Watershed Boundary Dataset. http://datagateway.nrcs.usda.gov (Accessed December 15 2016).
US Census Bureau. (2016). Tiger Products - Boundary files (state, county, and county subdivision). Tiger 2015 Versions. https://www.census.gov/geo/maps-data/data/tiger.html (Accessed December 15 2016).
Warren, P. S., Ryan, R. L., Lerman, S. B., & Tooke, K. (2011). Social and institutional factors associated with land use and forest conservation along two urban gradients in Massachusetts. *Landscape and Urban Planning, 102*, 82–92. https://doi.org/10.1016/j.landurbplan.2011.03.012.