

1 **One Size Does Not Fit All: Relationships Between Size of**
2 **Family Forest Holdings and Owner Attitudes and Behaviors**

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9

10 **Abstract**

11 An estimated 10 million families, individuals, trusts, and estates own 39% of the forestland in the
12 United States, excluding interior Alaska. Using segmented regression, the relationships between
13 size of forest holdings and the attitudes and behaviors of these family forest owners were
14 tested using data from the 2018 iteration of the USDA Forest Service’s National Woodland
15 Owner Survey. All of the 16 variables tested have significant relationships with size of forest
16 holdings and 13 have one or more breakpoints, ranging from 40 to 5,854 ac, where the
17 relationships between the variables change. Timber as a reason for owning, timber harvesting
18 activities, management plan, advice received, land certified, tax program participation, cost-
19 share, recreation, land tenure, recreation, taxes and heirs as concerns, land transfer, and income
20 from forestland have positive relationships to size of forest holdings; resident ownership has a
21 negative relationship; and wildlife as a reason for owning and owner age have mixed
22 relationships.

23 ***Keywords***

24 Family Forest Owners; National Woodland Owner Survey (NWOS); United States (US, USA);
25 USDA Forest Service; Forest Inventory and Analysis; segmented regression

26

27 Introduction

28 One out of every three acres of forestland in the United States is owned by families, individuals,
29 trusts, and estates, collectively referred to as family forest ownerships (Butler et al. 2020). They
30 own more forestland than the Federal government, corporate ownerships, including timber
31 investment management organizations (TIMOs) and real estate investment trusts (REITs), or any
32 other ownership group in the U.S. (Figure 1). The forest ownership patterns vary across the
33 country, with private ownerships dominating in the east and public ownerships dominating in the
34 west, but the patterns are often complex and there are large acreages of family forests across
35 most of the U.S. (Figure 2).

36 An estimated 10 million family forest ownerships [standard error (SE) = 0.2] collectively control
37 272 million acres of forestland¹ (SE = 1.7) across the U.S., excluding interior Alaska (Butler et
38 al. 2020). The number of family forest ownerships and the associated acreage has decreased in
39 recent years. Between 2013 (Butler et al. 2016b) and 2018 (Butler et al. 2020) the estimated
40 number of ownerships decreased by 10% and the associated acreage decreased by 5%. The
41 overall area of forestland across all ownerships also decreased between 2012 and 2017 (Oswalt
42 et al. 2019), but not as precipitously. The causes of the losses of family forests need to be
43 investigated, but there are indications that some of the loss is due to sale or conversion to
44 corporations, including limited liability companies, and deforestation (Caputo et al. 2020).

45 Family forest ownerships differ in terms of attitudes, behaviors, demographics, and basic
46 ownership characteristics, but there are broad patterns that can help us understand this important
47 group of ownerships. One of the most important attributes is size of forest holdings. It is arguable
48 that this is the single most powerful predictor because it directly influences many activities and is
49 correlated with numerous other characteristics. Size of holdings has been shown to be correlated
50 with timber harvesting behavior (Silver et al. 2015; Beach et al. 2005), reforestation and timber
51 stand improvements (Beach et al. 2005), management of invasive plants (Clarke et al. 2019),
52 general forest management activities (Floress et al. 2019), some ownership objectives (Butler et
53 al. 2016a), legacy and land tenure (Markowski-Lindsay et al. 2017, 2018), and enrollment in
54 preferential property tax (Meier et al. 2019), technical assistance (Kaetzel et al. 2009), and
55 carbon sequestration (Dickinson et al. 2012) programs.

56 In the U.S., the size of family forest holdings ranges from a single acre to many thousands of
57 acres. In terms of ownerships, 89% (SE = 4.5) of them have holdings of less than 50 acres of
58 forestland (Figure 3). But in terms of acreage, 72% (SE = 2.6) of the acres are in holdings of 50
59 or more acres of forestland. The overall distribution of size of holdings has remained relatively
60 constant over the past decade, but there have been decreases in the percentage of acreage in
61 holding of less than 500 ac and increases in the percentage of acreage in holdings of 500+ ac.

¹ Based on the USDA Forest Service, Forest Inventory and Analysis program's national definition of forestland:
"Land that has at least 10 percent crown cover by live tally trees of any size or has had at least 10 percent
canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To
qualify, the area must be at least 1.0 acre in size and 120.0 feet wide." (USDA Forest Service 2016).

62 These comparisons only include the states for which data are available from the 2006 (Butler
63 2008), 2013 (Butler et al. 2016b), and 2018 (Butler et al. 2020) iterations of the NWOS (i.e.,
64 excludes Alaska, Hawaii, Nevada, West Oklahoma, West Texas, and Wyoming). The sampling
65 procedures have not substantively changed among these iterations. The methods for estimating
66 sampling errors for the 2018 NWOS have been updated (Butler and Caputo 2020), but the
67 changes do not impact estimates of totals or percentages.

68 The average size of family forest holdings differs across the U.S. (Figure 4). In Connecticut,
69 Massachusetts, New Jersey, Hawaii, and New Hampshire, the average (mean) size is less than 10
70 ac. In Montana, Wyoming, Georgia, Mississippi, New Mexico, Texas, Louisiana, Oklahoma, and
71 Alabama, the average size is over 50 ac. These averages include all family forest ownerships
72 with 1+ ac of forestland, and the values are commensurately higher if a different minimum
73 threshold is used, such as 10+ ac (Figure 4B).

74 This article highlights results from the 2018 USDA Forest Service, National Woodland Owner
75 Survey (NWOS) with an emphasis on exploring relationships between size of family forest
76 holdings and landowner characteristics, including ownership objectives, timber harvesting,
77 management practices, program participation, and demographics. These variables were selected
78 to represent a broad range of ownership characteristics with an emphasis on variables that have
79 been the subject of previous research. The importance of size of forest holdings is something that
80 most practicing foresters know; the information presented here will help elucidate these
81 relationships and provide additional insights. Summaries of all data collected as part of the 2018
82 NWOS are available in Butler et al. (2020) and through the NWOS website
83 (www.fia.fs.fed.us/nwos). It is hoped that this information will help the design and
84 implementation of effective policies, programs, and services aimed at family forest ownerships.

85 **Methods**

86 *National Woodland Owner Survey*

87 The NWOS is a component of the USDA Forest Service, Forest Inventory and Analysis (FIA)
88 program and is tasked with quantifying private landowner attributes ranging from number of
89 landowners and size of holdings to reasons for owning and demographics. The 2018 NWOS was
90 implemented by the Family Forest Research Center (www.familyforestresearchcenter.org) – a
91 joint venture between the USDA Forest Service, Northern Research Station and the University of
92 Massachusetts Amherst (UMass), Department of Environmental Conservation. All methods were
93 approved through the processes established by the U.S. Office of Management Budget (OMB)
94 and the UMass Internal Review Board. Summaries of the implementation and estimation
95 procedures are provided below with more detailed information available in Butler et al. (2020)
96 and Butler and Caputo (2020).

97 The NWOS sample design is a derivative of the FIA sample design (Bechtold and Patterson
98 2005) and can be summarized as an area-based sample design with inclusion probabilities

99 proportional to size of holdings. The initial sample was drawn from the FIA plots and was
100 augmented to reach the target of 250 respondents per state. The sampling protocol involved:
101 dividing a state into hexagons; randomly locating a sample point in each hexagon; determining
102 the land use at each sample point; and identifying the ownership from publicly available property
103 ownership records. To determine the land use, the FIA inventory plots that were potentially
104 forested were, where permission was granted, visited and the land use was verified on the ground
105 using FIA field protocols (USDA Forest Service 2018). For the NWOS augmentation points,
106 high-resolution aerial photography was used to classify the land use. The family forest
107 ownerships identified through this process formed the sample for the results presented in this
108 article.

109 The NWOS data reported here were assigned a nominal date of 2018, but were collected over
110 two years, 2017 and 2018, and covered all of the U.S. except interior Alaska due to sampling
111 frame limitations. Implementation methods followed the Tailored Designed Method (Dillman,
112 Smyth, and Christian 2014). This involved up to four waves of contacts for each potential
113 respondent: a pre-notice postcard; a first questionnaire packet mailed approximately one week
114 later; a reminder/thank you postcard mailed approximately five days later; and, approximately
115 two weeks later, a second questionnaire packet was mailed to those who had not responded. The
116 questionnaire packets included a cover letter, a questionnaire, and a postage-paid reply envelope.
117 Prior to implementation, cognitive interviews were conducted to test questionnaire wording and
118 pre-testing was done to test implementation methods. A copy of the final questionnaire is
119 available at: www.fia.fs.fed.us/nwos/quest.

120 The survey had an overall cooperation rate of 40%, yielding 9,524 valid responses from family
121 forest ownerships that were used in the analyses presented here. To test for nonresponse bias,
122 1,048 randomly selected ownerships that did not respond to the mailings were contacted over the
123 phone and asked a subset of the questionnaire questions. Of the variables tested, 61% did not
124 significantly differ ($\alpha = 0.05$) between the mail and telephone respondents (Butler et al. 2020). Of
125 the remaining variables, none differed with a large effect size (*Cohen's d* ≥ 0.8). Overall, there
126 appears to be little nonresponse bias, but those responding via phone were slightly less active on
127 their land and less sure of future plans, and the results may slightly over-represent active owners
128 and those with more certainty about the future of their land. Item nonresponse was addressed
129 using multiple imputation (Buuren 2018).

130 Population-level estimates were calculated using weights incorporating the survey design,
131 response rates adjustments, unit nonresponse adjustments, and multiple imputations (Butler and
132 Caputo 2020). The base weights were the inverse of the inclusion probabilities, which were a
133 function of the acres of forestland owned, the area of forestland in the stratum, and sampling
134 intensity. The stratum forest areas were set to equal corresponding FIA plot-based estimates. The
135 weights account for the area-based design characteristic of the sample design, which results in
136 owners with larger holdings being more likely to be included in the sample. A propensity scoring
137 method (Brick 2013) was used to adjust weights for potential unit nonresponse biases. Variances
138 associated with point estimates were estimated using a bootstrapping approach (Efron and
139 Tibshirani 1986).

140 *Segmented Regression*

141 Segmented regression (Muggeo 2003), also known as breakpoint analysis or broken-line
142 regression, was used to test for non-linear relationships between size of holdings and the
143 variables of interest. As opposed to traditional regression techniques that assume a constant
144 relationship among variables across values (i.e., the same intercepts, coefficients, and error
145 terms), segmented regression allows for differentiated relationships for observations in different
146 ranges, e.g., different relationships for ownerships with smaller versus larger forest holdings.

147 The primary variable of interest for this article is size of forest holdings. The distribution of size
148 of forest holdings in the population and in the sample is highly skewed. A natural log
149 transformation of this variable produces a distribution that is much more normally distributed
150 (Figure 5), an assumption for numeric variables in many statistical models, and it is this log-
151 transformed variable that is used as a predictor in the models presented below. In terms of the
152 NWOS sample ($n = 9,518$), 9% of the respondents have forest holdings of 1-9 ac, 39% have
153 holdings of 10-99 ac, 39% have holdings of 100-999 ac, and 13% have holdings of 1,000 ac or
154 more.

155 The variables analyzed in conjunction with size of holdings are described in Table 1. These
156 variables were selected to represent different dimensions of ownership attributes that have been
157 discussed in previous research, were available from the NWOS dataset, and were limited in
158 number to be parsimonious and not generate an overwhelming number of models. The ownership
159 objectives, concerns, and likelihood of transferring variables were asked on the NWOS using 5-
160 point Likert scales and were recoded to binary variables coded as 1 if important or very
161 important, concern or great concern, likely or very likely, depending on the question, and 0
162 otherwise.

163 A total of 16 segmented regression models were analyzed with size of holdings as the sole
164 independent (or righthand side) variable. Logistic regression models were used for the binary
165 variables and ordinary least squares regression was used for the other variables. Breakpoints
166 were identified using a sequential approach. A first model, with no breakpoints, was created, the
167 existence of a breakpoint was assessed using a Score statistic, and if a significant ($p\text{-value} <$
168 0.05) breakpoint was found, a segmented regression analysis was used to identify the breakpoint
169 value (Muggeo 2003). This process was repeated until no additional, significant breakpoints
170 were found. Initial starting values used were $\ln(10)$ and $\ln(100)$. Sensitivity to starting values was
171 tested by increasing and decreasing start values for three models, having their primary residence
172 associated with their forestland, timber harvesting for sale in the previous five years, and
173 recreation on the forestland in the previous five years, with no significant differences found
174 among the resulting breakpoints. Modeling was implemented using the `glm` (R Core Team 2019)
175 and `segmented` (Muggeo 2008) functions in the R statistical environment.

176 In addition to the regression models, population-level summary statistics for each of the variables
177 of interest were generated for four size classes: 1-9, 10-99, 100-999, and 1,000+ ac. The
178 thresholds for these size classes are based on a log scale and are consistent with the threshold
179 minima used in Butler et al. (2020).

180 Results

181 An estimated 62% of the family forest ownerships in the U.S. have forest holdings that are 1-9 ac
182 in size, but 58% of the family forest acres are in holdings of 100 ac or more. The mean forest
183 holding size is 28 ac per ownership (SE = 0.7; median = 5 ac). Looking just at family forest
184 ownerships with 10+ ac of forestland, the mean holding size is 69 ac per ownership (SE = 0.9;
185 median = 27 ac).

186 Looking across all family forest ownerships (Table 2, “Total (1+)” column), it is apparent that
187 wildlife is important for most owners, many own forests as part of their primary residence,
188 owners have multiple concerns related to their land, most have owned their land for a long time,
189 and many are relatively advanced in age. It is also evident that most owners have not recently
190 conducted a commercial timber harvest, do not have a management plan, have not recently
191 received advice about their forestland, have not participated in traditional forestry assistance
192 programs, and do not receive appreciable amounts of their annual income from their forestland.
193 These statements are accurate in terms of both ownerships and acres, but the statistics can be
194 quite different in terms of the two units. For example, 8% of the family forest ownerships have
195 commercially harvested trees in the previous five years, but collectively they control 28% of the
196 family forestland. These differences are smaller when examining 10+ ac ownerships and are
197 negligible within the constrained size bins reported in Table 2.

198 All of the variables tested are significantly related to size of forest holdings (i.e., *p-values* < 0.05
199 for the size of forest holding variable in the initial regression models). The averages for these
200 variables across four size classes (1-9, 10-99, 100-999, and 1,000+ ac) are shown in Table 2 and
201 the regression relationships, including breakpoints, are summarized in Figure 6. Additional
202 details on the breakpoints and regression models are included in the Supplemental Materials.

203 The descriptive statistics show strong relationships for most of the variables tested across the *a*
204 *priori* size classes (Table 2). As opposed to the statistics for the 1+ and 10+ ac totals, the values
205 and patterns in terms of acres and ownerships are very similar within each size class. The values
206 for most variables increase as size class increases, and sometimes dramatically. Having timber
207 production as an important or very important ownership objective, having harvested trees for sale
208 in the previous five years, having a written forest management plan, and having received forest
209 management advice in the previous five years have considerable increases across size classes.
210 For example, only 4% of the ownerships with 1-9 ac and 13% of the ownerships with 10-99 ac
211 have harvested trees for sale in the previous five years, but the percentages increase to 32% and
212 45% for ownerships with 100-999 and 1,000+ ac, respectively.

213 Having wildlife as an important or very important reason for owning forestland, having taxes or
214 heirs as concerns or great concerns, and recreating on their forestland are high across the range
215 of size classes, but these too show higher values for larger classes. For example, the proportions
216 of ownerships having wildlife as an important or very important reason for owning forestland
217 goes from 70% for 1-9 ac ownerships to 76% for 10-99 ac ownerships to 80% for ownerships in
218 the 100-999 and 1,000+ ac classes.

219 Having their land green certified, participating in tax programs, and cost-share enrollment are
220 generally low across size classes, but the probabilities increase across size classes. For example,
221 3% of the ownerships in the 1-9 ac size class report participation in a preferential property tax
222 program versus 16%, 26%, and 35% for ownerships in the 10-99, 100-999, and 1,000+ ac
223 classes, respectively.

224 Having their primary residence associated with their forestland is the only variable that
225 consistently decreases across size classes, but it is relatively common across all classes. The
226 percentage of ownerships having their primary residence associated with their forestland goes
227 from 77% for 1-9 ac ownerships to 43% for ownerships with 1,000+ ac.

228 The descriptive results and segmentation models are largely in agreement, as expected, but the
229 regression models allow for much more nuanced examination of the relationships. All of the
230 relationships between size of holdings and the variables of interest in the regression models are
231 significant (i.e., correlated with size) and the confidence bands are relatively tight, but the
232 intercepts, slopes, and numbers of breakpoints vary substantially across models (Figure 6). The
233 dominant pattern is a sharper increase up to the breakpoint followed by a continued, but slower,
234 increase, but this pattern varies by model. The x-axis across all of the charts in Figure 6 are on a
235 log scale, as is acres in the models, due to the distribution of size of forest holdings (Figure 5);
236 this means that a straight-line relationship is actually exponential in nature.

237 The number of breakpoints (i.e., points at which there are significant, structural changes in the
238 relationships between the variables) varies from no breakpoints for having received forest
239 management advice in the previous five years, land tenure, and being concerned or greatly
240 concerned about being able to hold onto land for future generations to two breakpoints for owner
241 age and percentage of income derived from their forestland; all other models have one
242 breakpoint. But again, even in the absence of any breakpoints, there are still significant
243 relationships between the variables of interest and size of holdings, it is just that the relationships
244 do not significantly change over the range of size of holdings. The values of the breakpoints
245 range from 40 ac for having a home associated with their forestland to 1,737 ac for participation
246 in a cost-share program.

247 Having a home associated with their forestland is the only attribute that has a consistent, negative
248 relationship with size of holdings (Figure 6A). The predicted probability goes from 0.8 at 1 ac to
249 0.6 at 40 ac. The probability continues to decrease with size after this 40-acre breakpoint, but at a
250 slower rate (i.e., slope of -0.4 up to 40 ac and -0.2 after 40 ac).

251 Rating timber production as an important or very important reason for owning forestland has a
252 low predicted probability for smaller parcels (Figure 6B). The probability rises quickly until the
253 278-acre breakpoint, after which the probability continues to increase, but at a slower rate. The
254 predicted probability crosses the 0.5 threshold (i.e., 50/50 probability) around 1,000 ac.

255 The predicted probability for rating wildlife as an important or very important reason for owning
256 forestland is high (i.e., over 0.6) across the range of size holdings. The predicted probability is
257 0.6 for 1 ac and rises to 0.8 at 67 ac. After that breakpoint, the predicted probability has a slight
258 negative relationship to size of holdings.

259 The predicted probability of having harvested timber for sale in the previous five years begins
260 low (0.02), but then rises quickly (Figure 6D). The increase in the predicted probability is
261 precipitous up to the 442-ac breakpoint and then continues to rise, but at a more modest rate.
262 Harvesting probability crosses the 0.5 threshold at around 2,000 ac.

263 The predicted probability of having a written forest management plan is relatively low across all
264 holding sizes and does not cross the 0.5 threshold until almost 10,000 ac (Figure 6E). The
265 predicted probability goes from 0.01 to 0.3 between 1 and 130 ac. The rate of increase continues
266 after the 130-ac breakpoint, but more slowly.

267 The predicted probability of having received forest management advice in the previous five years
268 has a linear relationship with size of forest holdings and no identified breakpoints (Figure 6F).
269 The predicted probability ranges from 0.05 to 0.9 and crosses the 0.5 threshold at about 1,000 ac.

270 The predicted probability of having their forestland certified, participating in a tax program, or
271 participating in a cost-share program is low across virtually all holding sizes (Figures 6G, 6H,
272 and 6I). For all of these models, the probabilities increase until the breakpoints and then the
273 increases dampen for certification and tax programs and the relationship reverses (i.e., becomes
274 negative) for cost-share. The breakpoints for these models range from 60 ac for tax programs to
275 529 ac for certification to 1,737 ac for cost-share. Tax programs is the only one of these models
276 that approaches the 0.5 threshold and it does not do so until nearly 100,000 ac.

277 Land tenure has a linear relationship with size of forest holdings and no identified breakpoints
278 (Figure 6J). The predicted tenures range from 21 to 31 years.

279 The predicted probability of recreating on their land in the previous five years is above 0.5 for all
280 size holdings (Figure 6K). The predicted probability is 0.6 for 1 ac and rises rapidly to 0.9 at 142
281 ac. It then essentially levels off.

282 Citing high property taxes or keeping land intact for future generations as concerns or great
283 concerns have high (i.e., above 0.5) predicted probabilities across all holding sizes (Figures 6L
284 and 6M). The tax concern probability is about 0.8 between 1 and 85 ac and then begins to climb
285 after this breakpoint to a top predicted probability of 0.9. The legacy concern probability ranges
286 from 0.6 to 0.9 with no identified breakpoints.

287 Transferring some or all of their land in the next five years has a low predicted probability across
288 all size holdings and does not cross the 0.5 threshold, although it does get close for the largest
289 size holdings (Figure 6N). The predicted probability is 0.1 at 1 ac, it rises to 0.2 at 1,700 ac, and
290 then increases more rapidly following this breakpoint to a maximum value of nearly 0.5.

291 Owner age has a nonlinear relationship with size of holding with predicted ages that range from
292 56 to 74 years (Figure 6O). The predicted age goes from 61 to 66 from 1 to 85 ac, then it remains
293 relatively flat until it begins to decrease at the second breakpoint of 5,854 ac.

294 The predicted percentage of income from forestland is low across most size holdings (Figure
295 6P). The predicted percentage is less than 2% until 112 ac. After this breakpoint, the predicted

296 percentage begins to increase. At 685 ac, the predicted value is 8%. After this second breakpoint,
297 the predicted percentage increases faster and reaches a zenith of 42% at 100,000 ac.

298 **Discussion**

299 Summarizing the variables examined in this article, America's family forest owners tend to be
300 more interested in amenity than financial objectives, they are not participating in traditional
301 forestry programs, they have multiple concerns related to their land, and they tend to be older.
302 But there are substantial differences depending on size of forest holdings.

303 Size of forest holdings is a powerful predictor of many family forest ownership attributes and is
304 conceivably *the* most powerful predictor of family forest ownership attributes. The results
305 presented here help validate this assumption, which is also well supported by previous studies
306 (Silver et al. 2015; Beach et al. 2005; Floress et al. 2019). These relationships are important in
307 terms of understanding family forest owners and designing and implementing efficacious
308 programs, services, and policies.

309 For example, participation by family forest ownerships in carbon sequestration programs is an
310 increasingly important topic (Khanal et al. 2016; Kelly, Gold, and Tommaso 2017) and size of
311 holdings has an important impact on who is participating. At least how most of the programs are
312 currently structured, there are substantial costs or other barriers for enrolling and monitoring
313 associated with the programs that make it difficult for ownerships with holdings of less than a
314 few thousand acres to participate, but there are efforts to develop alternative approaches, such as
315 the Family Forest Carbon Program (American Forest Foundation 2020). Similarly, many forest
316 certification programs have substantial barriers to entry for ownerships with smaller holdings and
317 as a result, some have turned to group certification approaches (Boakye-Danquah and Reed
318 2019).

319 There are significant relationships between size of forest holdings and all of the variables tested,
320 but the magnitudes of these relationships (i.e., the slopes in the regression models) and the
321 numbers and values of the breakpoints vary. Although there are relationships with size, some
322 variables have predicted probabilities that are consistently high (e.g., above 0.5) across the size
323 spectrum, some are consistently low (e.g., below 0.5), and some that span a wide range of values.
324 Identifying where the predicted probabilities cross the 0.5 probability threshold can be
325 particularly insightful and may represent tipping points.

326 For participation in tax programs, owning forestland as part of a residence, and having wildlife
327 as an ownership objective, the breakpoints are relatively low, less than 100 ac. The residency
328 breakpoint is at 40 ac, which happens to coincide with a standard land subdivision in parts of the
329 U.S. where the Public Land Survey System, also known as the Township and Range system, was
330 used to divide land for settlement. Although wildlife as an ownership objective is high across
331 holding sizes, this is one of the few variables tested where the direction of the relationship
332 changes with the probability decreasing, albeit slightly, after the 67-acre breakpoint.

333 Minimum acreage thresholds exist for most preferential property tax programs (Kilgore et al.
334 2018) and for many other incentive and assistance programs. The minima help focus programs
335 on the greatest number of acres (i.e., the smaller number of ownerships who own the greater
336 percentage of acres) and consequently gain efficiencies through economies of scale. Many of
337 these programs also have implicit or explicit timber production objectives, and these minima
338 help focus the programs on the more financially viable acres. But these program designs may
339 also exclude some of the most vulnerable ownerships – i.e., those with smaller holdings. If
340 parcellation, development, and other threats are occurring on smaller parcels, exclusion from
341 these programs could exasperate the problems. As with all policies, it is important to identify
342 where the limited resources will accomplish the most to meet the program goals.

343 Concerns regarding taxes are also well documented (Meier et al. 2019). The results here support
344 this general finding and show this concern is high across size holdings, but is highest among
345 owners with the largest holdings. This makes sense given that smaller parcels can have higher
346 per acre tax assessments (due to location and other factors), larger holdings may have substantial
347 total tax burdens due to large acreages, and property taxes are due every year, regardless of
348 whether income is generated from the land.

349 The two variables tested that are directly related to timber production, timber as an important or
350 very important ownership objective and timber harvesting in the previous five years, have
351 breakpoints at 278 and 442 ac, respectively. The probabilities for these attributes are low for
352 ownerships with smaller holdings and increase rapidly with size of holdings up to the
353 breakpoints where the increase decelerates. The predicted probabilities of both of these reach 0.5
354 around 1,000 ac and never reach 0.75, even for the largest size categories. As the timber
355 harvesting variable is constrained to the previous five years, this will show a lower probability
356 versus looking at whether an ownership has ever harvested. That being said, this variable is an
357 indicator of active/frequent timber harvesters, it allows for better tracking over time, and it better
358 deals with issues related to land tenure.

359 Forest management plans and advice are often related to timber management. Management plans
360 has breakpoint at 130 ac and crosses the 0.5 probability threshold around 10,000 ac and having
361 received advice in the previous five years has no breakpoints and crosses the 0.5 probability
362 threshold around 1,000 ac. Although the likelihood of having a management plan increases with
363 size, the overall probability is low for most ownerships and this may reflect the disconnect
364 between management plans and owners' objectives discussed by Kittredge (2009) and
365 VanBrackle (2015). Having received advice in the previous five years is more likely than having
366 a management plan, but it too is generally low. This value will certainly be higher if the
367 timeframe for receiving advice is expanded, but regardless, there is a lot of room for increased
368 communications with owners across the size spectrum.

369 Another variable related to timber harvesting, and also other revenue streams, is percentage of
370 annual income generated by their forestland. The predicted percentage is very low until 113 ac
371 when it begins to increase, and this increase accelerates after 686 ac. But it remains low across
372 most holding sizes with the predicted value not reaching 10% until about 1,000 ac.

373 One of the reasons for these observed relationships with the timber-related variables is
374 economies of scale. For financial activities, such as timber harvesting, the per acre (or per
375 volume) harvested costs are very high for small holdings, they decrease as size increases, and
376 eventually they reach an asymptote. This is due to the costs of moving logging equipment,
377 transaction costs, and other factors. Indeed, some studies suggest that holdings below a certain
378 threshold are not financially viable (D'Amato et al. 2010), but of course this threshold will vary
379 depending on forest and market conditions.

380 Recreation, including hunting, is a common and well-documented activity on family forestlands
381 in the U.S. (Caputo and Butler 2017), as well as in other countries (Lawrence et al. 2020), and is
382 common across holding sizes. The probability is lower, but still over 0.5, for smaller holdings,
383 but it quickly increases and approaches an asymptote of over 0.9 after the 145-acre breakpoint.

384 Land transfer has a very high breakpoint value, 1,700 ac, with a rapid increase in probability of
385 transferring land after this breakpoint. The relationship with land transfer may be related to the
386 fact that the NWOS asks about the likelihood of transferring some or all of their land. Although
387 there are no data from the NWOS to verify it, it is reasonable to assume that owners with larger
388 holdings are more likely to have separate parcels or portions of parcels that they may be
389 interested in selling or transferring, without disposing of all of their land assets.

390 The probability of participating in a cost-share program is relatively low across holding sizes, but
391 the direction of the relationship switches at the 1,737-acre breakpoint and becomes negative. The
392 specific reasons need to be further investigated, but the largest ownerships may not qualify or
393 compete well for the cost-share programs, they may have other ways to pay for the activities, the
394 programs may be less attractive or poorly suited to their needs, or economies of scale may make
395 these programs less necessary for them.

396 Landowner age has two breakpoints, but the predicted age is relatively high across holding sizes.
397 Interestingly, the predicted age begins to decrease for ownerships with especially large holdings
398 (i.e., $\geq 5,854$ ac). The age of the owners, the likelihood of transferring land, and the importance
399 of these shifts for the future of family forests makes intergenerational land transfer and related
400 topics of great importance, and some recent efforts have been focusing on them (Markowski-
401 Lindsay et al. 2018).

402 Three variables, having received advice, land tenure, and concerns related to keeping land intact
403 for heirs, show no breakpoints. But again, this does not imply there are no relationship to size of
404 holdings, it is just that the relationships are linear and continuous.

405 The results of this study have analytical implications. The relationships between size of holdings
406 and various attributes are often strong and nonlinear. Given the underlying distribution of family
407 forest ownerships (Figure 5), a log-transformation is a useful first step for creating a variable that
408 has characteristics closer to a normal distribution and the analytical advantages that provides.
409 Segmenting the population by size of holdings and creating separate models for each segment
410 may better illuminate patterns. A challenge is finding the appropriate breakpoint(s) and this will
411 vary depending on the objectives of the study. The methods used here present one approach for
412 identifying the breakpoints. Another analytical approach may be to use non-parametric models,

413 such as classification and regression trees, that do not rely on the same assumptions as traditional
414 regression methods.

415 Most previous research that has developed family forest ownership typologies has done so from
416 the perspective of ownership objectives (Ficko et al. 2019). This approach has proven useful for
417 many projects, but objectives alone can only go so far in explaining attitudes and behaviors.
418 Snyder et al. (2019) segmented family forest ownerships into two categories, ownerships with 1-
419 9 and 10+ ac of forestland, and found that some attributes varied significantly between these
420 groups and some did not. A hybrid approach for creating ownership typologies that brings
421 together landowner (e.g., attitudes) and land (e.g., size of holdings) attributes should be explored.

422 The models presented in the paper are, by design, very simple. This allows for the relationships
423 with size of forest holdings to be more easily observed. But fuller models are needed to fully
424 explore the relationships for specific topics. Depending on the topic, it may be useful to also
425 include variables related to geography, past activities, demographics, association membership,
426 and other landowner and land characteristics along with variables related to policies and markets.

427 The results presented here summarize an array of attitudes and behaviors at each holding size,
428 but there is of course variability at each point across the size spectrum. For example, even though
429 the predicted probability of timber harvesting for small holdings is low, it certainly does happen,
430 it is just that it is probabilistically less likely to happen than for ownerships with larger holdings.
431 As with all models, there is also uncertainty associated with the results both in terms of the
432 underlying data and the models themselves. This latter fact is reflected in the confidence
433 intervals associated with the estimates.

434 The specific thresholds identified here vary by attribute, but will likely change to some degree
435 given different datasets. As such, it would be useful to rerun these analyses to see how consistent
436 the breakpoints are with other populations or for the same population at other points of time.
437 Indeed, size of forest holdings are continually changing, through parcelization and consolidation,
438 and the changes in sizes of holdings may also be important to consider (Kilgore and Snyder
439 2016).

440 The focus of the discussion has been in terms of ownerships, but it is important to also consider
441 the differences between ownerships and acres. This is especially true given the differences in
442 distributions in terms of these two units (Figure 3). The analyses presented here take into account
443 size of holdings, but the implications in terms of the landscape need to be considered. As
444 presented in Table 2, there can be substantial differences in the percentages of ownerships that
445 have a specific attribute versus the percentage of the forestland that they own. For example, an
446 estimated 11% of the family forest ownerships have received advice about their forestland in the
447 previous five years, but collectively they control 34% of the family forestland. Both are
448 legitimate ways of looking at family forest statistics, but the “best” metric will depend on the
449 specific topic of interest, and often both should be considered. These differences largely
450 disappear when ownerships are segmented by size of holdings, as is done in Table 2.

451 Many of the dependent variables tested are undoubtedly correlated with each other, e.g., timber
452 harvesting for sale in the previous five years and having timber production as an important or

453 very important ownership objective. This does not negate the validity of the models presented,
454 which were developed to look expressly at the relationships between these variables and size of
455 holdings, but these correlations and additional dependent variables would need to be considered
456 when developing more detailed models aimed at more fully explaining specific attributes.

457 A number of studies have used surrogates for size of forest holdings. For example, Wear et al.
458 (1999) and Vickery et al. (2009) showed that population density is negatively correlated with
459 timber availability. This relationship is in part due to the relationship between population density
460 and size of forest holdings. Other factors likely related to size of forest holdings are amenity
461 features, such as distance to water or public lands (Snyder et al. 2007), land value for alternative
462 uses, such as agriculture and development, markets for timber and other resources, land use
463 policies, and land settlement patterns (i.e., historical ownership patterns), but additional research
464 is needed to verify the relationships.

465 The importance of size of forest holdings has been demonstrated not just in the U.S., but in
466 numerous other nations that have ownership patterns that are similar to the U.S. In regards to
467 other developed countries, strong relationships have been shown between size of holdings and
468 various landowner attributes in, for example, Australia (Harrison and Herbohn 2005), France
469 (Petucco, Abildtrup, and Stenger 2015), and Norway (Bashir, Sjølie, and Solberg 2020). But size
470 is also germane in developing countries and countries in transition. In the international literature,
471 there is reference to “small-scale” forestry (Harrison, Herbohn, and Niskanen 2002) and
472 extensive examination of how forests contribute to human sustenance and livelihoods, and the
473 relationships with size of holdings are often included.

474 **Conclusions**

475 The results from the 2018 NWOS reinforce the fact that family forest ownerships are multi-
476 faceted. Of the estimated 10 million family forest ownerships across the U.S., who collectively
477 control 272 million ac of the nation’s forestland (more than any other ownership group!), most of
478 the ownerships are in smaller (< 10 ac) holdings, but most of the acres are in larger (≥ 100 ac)
479 holdings. Size of forest holdings is significantly associated with all of the attributes tested, and
480 most, but not all, have one or more size breakpoints. The fact that the numbers and values of the
481 breakpoints differ shows that there is no universal threshold and that variation in breakpoint
482 values is objective-dependent – there is no one size that fits all for understanding landowner
483 attitudes, management behaviors, analyzing ownership data, or designing and implementing
484 programs, policies, and services. For topics such as timber harvesting, it may make sense to
485 focus on larger forest holding, while for topics such as parcellation it may make sense to focus
486 on smaller forest holdings, and for topics such as wildfire mitigation there is justification for
487 focusing based on location and site conditions regardless of size of holdings.

488 The ideal approach to classifying or segmenting owners depends on one’s objective. The
489 traditional approach for classifying (private) forest ownerships used by the USDA Forest Service
490 is based on a combination of legal ownership structure and ownership objectives. Neither of
491 these are simple to consistently implement across a broad-scale. An alternative is to use size of

492 forest holdings. This approach needs to be carefully considered in terms of implications for
493 maintaining historical data series and the feasibility of collecting these data for all ownerships
494 sampled (not just respondents), but these issues are likely addressable. Regarding a minimum
495 acreage for reporting, the USDA Forest Service has a 1-acre minimum for defining forestland,
496 and this should be carried forth in the ownership definitions. As there are no universal
497 breakpoints, data should continue to be provided in formats that allow for different thresholds to
498 be used by different end-users.

499 The relationships between holding size and forest owner attributes have important implications
500 for many of forestry's biggest challenges including wildfire, invasive species, timber supply,
501 restoration, resiliency, and keeping forests as forests. These challenges are dynamic and so too
502 are family forest ownerships. As owners' needs and attitudes change and as forests are bought
503 and sold, opportunities will arise for holdings to be parcelized and consolidated and for
504 associated attributes to change. Forest policies should be designed to provide owners what they
505 need, when they need it, how they want it to help them continue to provide the myriad benefits
506 provided by family forests from across the spectrum of forest holding sizes.

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648 **Supplemental Materials**

649 Appendix I. Breakpoints for segmented regression models relating size of family forest holdings
650 and selected variables from the 2018 USDA Forest Service, National Woodland Owner Survey.

651 Appendix II. Summaries of regression models relating size of family forest holdings and selected
652 variables from the 2018 USDA Forest Service, National Woodland Owner Survey.

653

654

655 **Tables Captions**

656 Table 1. Variables from the USDA Forest Service, National Woodland Owner Survey used to
 657 analyze relationships between size of forest holdings and family forest ownership attitudes and
 658 behaviors.

Variable name	Description	Units/coding
LN_ACRES	Natural log of size of forest holding	Natural log of acres
HOME	Part of primary residence	1 = Yes; 0 = No
OBJ_TIMBER	Timber production is rated an important or very important on a 5-point Likert scale	1 = Yes; 0 = No
OBJ_WILDLIFE	Wildlife habitat is rated an important or very important on a 5-point Likert scale	1 = Yes; 0 = No
HARVEST	Harvested timber for sale in the previous 5 years	1 = Yes; 0 = No
PLAN	Has a written forest management plan	1 = Yes; 0 = No
ADVICE	Has received forest management advice in the previous five years	1 = Yes; 0 = No
CERTIFIED	Enrolled in a forest certification program	1 = Yes; 0 = No
TAX_PROGRAM	Enrolled in a preferential forest property tax program	1 = Yes; 0 = No
COST_SHARE	Enrolled in a forest cost-share program	1 = Yes; 0 = No
TENURE	Length of land tenure	Years
REC	Owner or spouse has recreated on their forestland in the previous 5 years	1 = Yes; 0 = No
CNC_TAXES	Property taxes are a concern or great concern, on a 5-point Likert scale	1 = Yes; 0 = No
CNC_HEIRS	Ability to keep land intact for future generations is a concern or great concern, on a 5-point Likert scale	1 = Yes; 0 = No
TRANSFER	Likely or very likely, on a 5-point Likert scale, to sell or transfer some or all of their forestland in the next 5 years	1 = Yes; 0 = No
AGE	Age of the owner who is the primary decision maker	Years
FOREST_INCOME	Percentage of household's income derived from their forestland	Percent

659

660

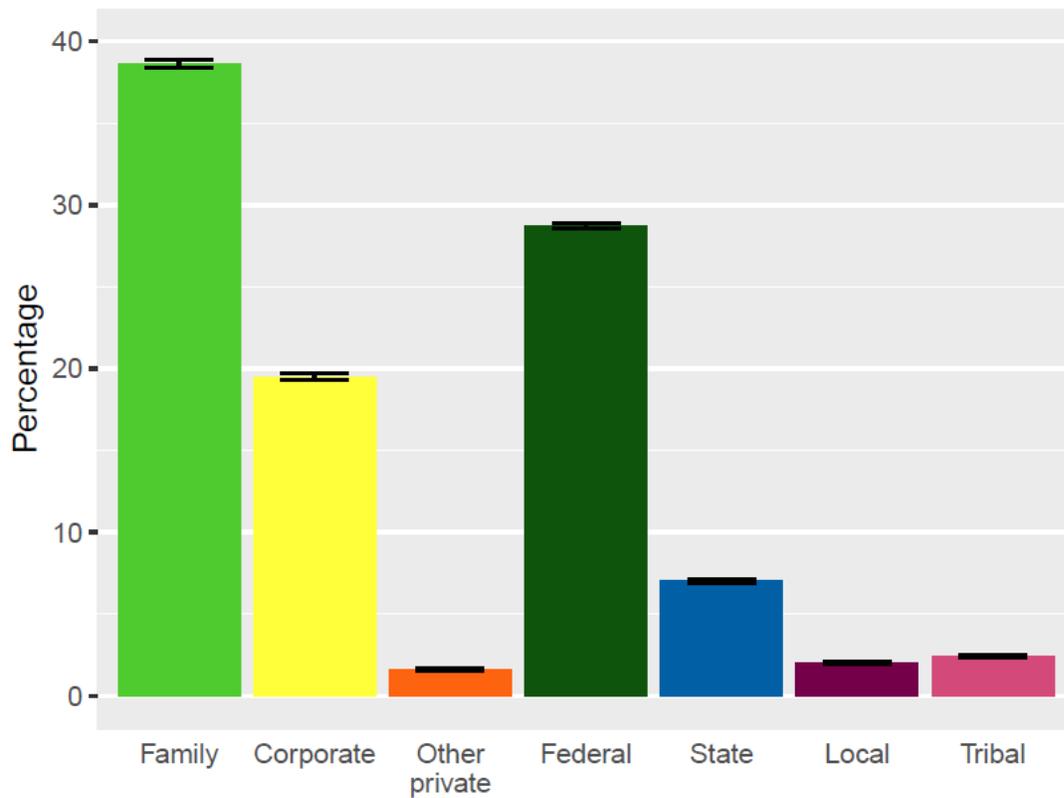
661 Table 2. Summaries of selected variables, weighted by ownerships and acreage, for family forest
662 ownerships by size of holdings, U.S., 2018. For continuous variables, the summary statistics are
663 weighted means; for categorical variables, the summary statistics are weighted proportions where
664 the attribute is present (i.e., value = 1). Standard errors are listed parenthetically next to the
665 estimates.

Variable	Units	Size of forest holdings (ac)								Total (1+ ac)	Total (10+ ac)		
		1-9		10-99		100-999		1,000+					
HOME (proportion)	Ownerships	0.77	(0.02)	0.63	(0.01)	0.51	(0.01)	0.43	(0.02)	0.71	(0.02)	0.62	(0.01)
	Acres	0.75	(0.02)	0.60	(0.01)	0.48	(0.01)	0.41	(0.02)	0.53	(0.01)	0.52	(0.01)
OBJ_TIMBER (proportion)	Ownerships	0.05	(0.01)	0.18	(0.01)	0.41	(0.01)	0.45	(0.02)	0.11	(0.01)	0.21	(0.01)
	Acres	0.05	(0.01)	0.23	(0.01)	0.45	(0.01)	0.45	(0.02)	0.34	(0.01)	0.37	(0.01)
OBJ_WILDLIFE (proportion)	Ownerships	0.70	(0.03)	0.76	(0.01)	0.80	(0.01)	0.80	(0.02)	0.73	(0.02)	0.77	(0.01)
	Acres	0.69	(0.02)	0.78	(0.01)	0.79	(0.01)	0.81	(0.02)	0.78	(0.01)	0.79	(0.01)
HARVEST (proportion)	Ownerships	0.04	(0.01)	0.13	(0.01)	0.32	(0.01)	0.45	(0.02)	0.08	(0.01)	0.16	(0.01)
	Acres	0.04	(0.01)	0.16	(0.01)	0.36	(0.01)	0.43	(0.02)	0.28	(0.01)	0.30	(0.01)
PLAN (proportion)	Ownerships	0.01	(0.00)	0.08	(0.01)	0.25	(0.01)	0.38	4	0.05	(0.00)	0.11	(0.00)
	Acres	0.02	(0.00)	0.12	(0.01)	0.27	(0.01)	0.42	(0.02)	0.23	(0.01)	0.24	(0.01)
ADVICE (proportion)	Ownerships	0.06	(0.01)	0.15	(0.01)	0.33	(0.01)	0.61	(0.02)	0.11	(0.01)	0.18	(0.01)
	Acres	0.06	(0.01)	0.19	(0.01)	0.38	(0.01)	0.62	(0.02)	0.34	(0.01)	0.36	(0.01)
CERTIFIED (proportion)	Ownerships	0.01	(0.01)	0.02	(0.00)	0.05	(0.00)	0.10	(0.01)	0.01	(0.00)	0.02	(0.00)
	Acres	0.00	(0.00)	0.02	(0.00)	0.06	(0.00)	0.10	(0.01)	0.05	(0.00)	0.05	(0.00)
TAX_PROGRAM (proportion)	Ownerships	0.03	(0.01)	0.16	(0.01)	0.26	(0.01)	0.35	(0.02)	0.09	(0.01)	0.17	(0.01)
	Acres	0.04	(0.01)	0.19	(0.01)	0.29	(0.01)	0.32	(0.02)	0.24	(0.01)	0.26	(0.01)
COST_SHARE (proportion)	Ownerships	0.01	(0.00)	0.02	(0.00)	0.11	(0.01)	0.30	(0.02)	0.02	(0.00)	0.04	(0.00)
	Acres	0.00	(0.00)	0.03	(0.00)	0.14	(0.01)	0.31	(0.02)	0.12	(0.00)	0.13	(0.01)
TENURE (years)	Ownerships	19.53	(0.70)	23.95	(0.40)	25.69	(0.36)	27.36	(0.78)	21.33	(0.48)	24.21	(0.35)
	Acres	20.05	(0.59)	24.33	(0.32)	25.90	(0.34)	27.83	(0.70)	25.30	(0.22)	25.69	(0.23)
REC (proportion)	Ownerships	0.65	(0.04)	0.87	(0.01)	0.96	(0.00)	0.96	(0.01)	0.74	(0.02)	0.88	(0.01)
	Acres	0.73	(0.02)	0.90	(0.01)	0.96	(0.00)	0.97	(0.01)	0.92	(0.00)	0.94	(0.00)
CNC_TAXES (proportion)	Ownerships	0.73	(0.04)	0.77	(0.01)	0.80	(0.01)	0.83	(0.02)	0.74	(0.02)	0.77	(0.01)
	Acres	0.76	(0.02)	0.77	(0.01)	0.81	(0.01)	0.86	(0.01)	0.80	(0.01)	0.80	(0.01)
CNC_HEIRS (proportion)	Ownerships	0.66	(0.03)	0.73	(0.01)	0.80	(0.01)	0.83	(0.02)	0.69	(0.02)	0.74	(0.01)
	Acres	0.68	(0.02)	0.75	(0.01)	0.81	(0.01)	0.84	(0.01)	0.78	(0.01)	0.79	(0.01)
TRANSFER (proportion)	Ownerships	0.14	(0.02)	0.15	(0.01)	0.18	(0.01)	0.18	(0.02)	0.15	(0.01)	0.15	(0.01)
	Acres	0.13	(0.02)	0.15	(0.01)	0.19	(0.01)	0.23	(0.02)	0.18	(0.01)	0.18	(0.01)
AGE (years)	Ownerships	62.57	(0.69)	64.55	(0.30)	66.41	(0.31)	66.30	(0.53)	63.43	(0.44)	64.81	(0.26)
	Acres	62.19	(0.55)	65.31	(0.25)	66.55	(0.26)	66.36	(0.48)	65.78	(0.17)	66.04	(0.17)
FOREST_INCOME (percent)	Ownerships	0.28	(0.10)	0.83	(0.09)	3.62	(0.21)	16.70	(1.03)	0.67	(0.07)	1.29	(0.08)
	Acres	0.47	(0.19)	1.03	(0.10)	5.05	(0.32)	21.99	(1.33)	6.41	(0.31)	6.84	(0.33)

666

667

668 **Figure Captions**

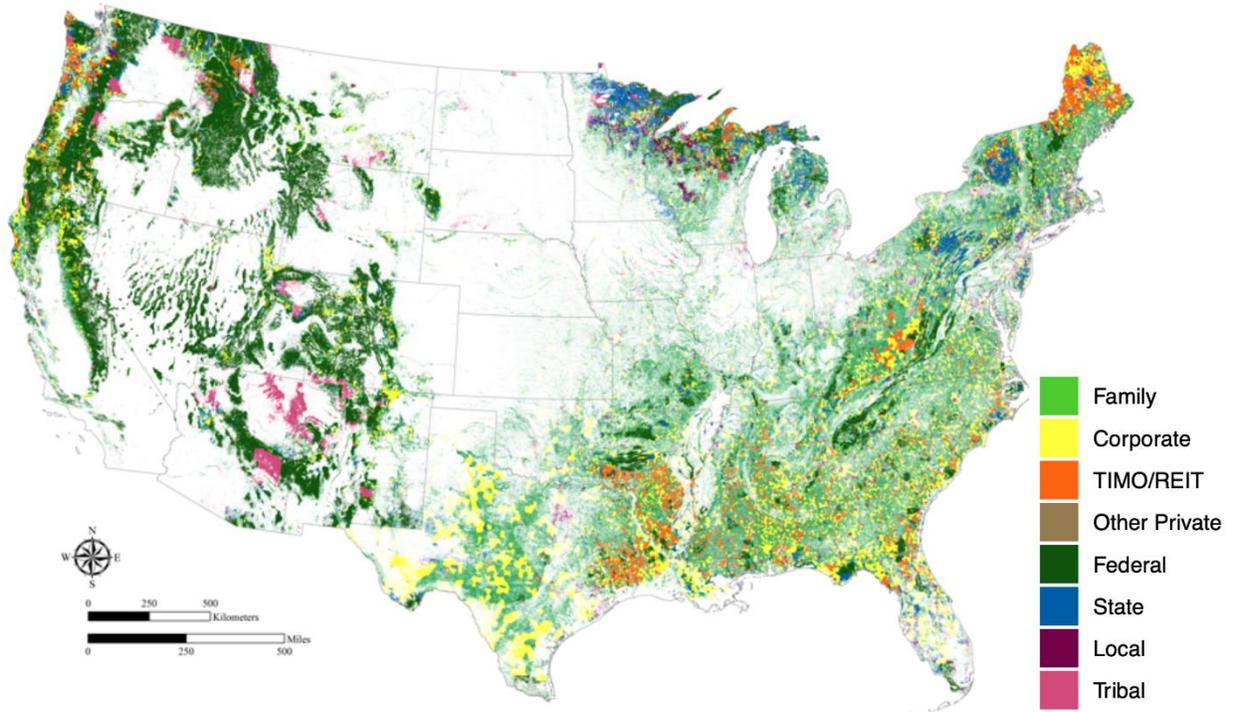


669

670 Figure 1. Forest area by ownership category, U.S.*, 2018 (Butler et al. 2020). Error bars
671 represent 95% confidence intervals.

672 * Excluding interior Alaska.

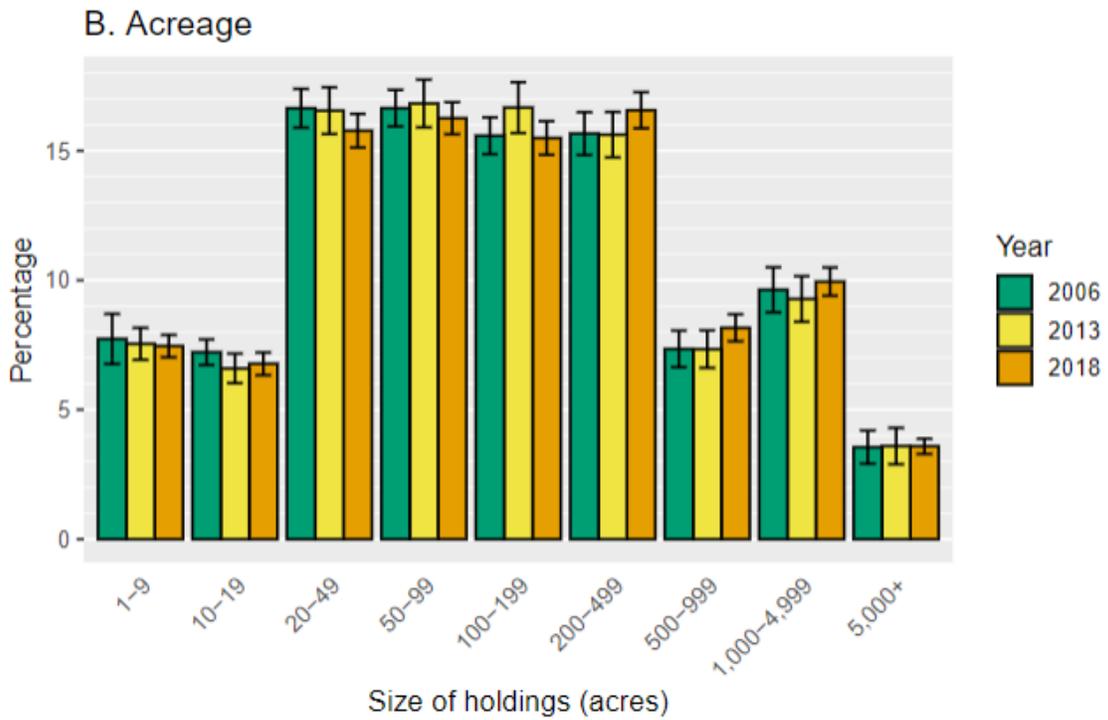
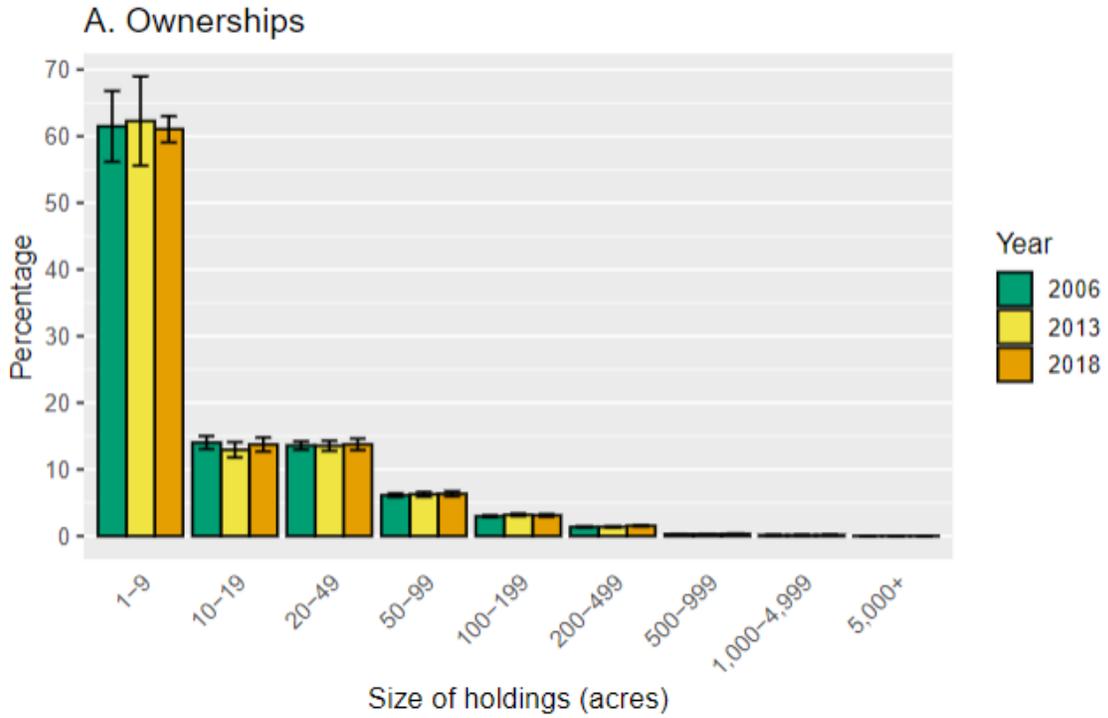
673



674

675 Figure 2. Forest ownership, U.S., 2018 (Sass, Butler, and Markowski-Lindsay 2020).

676

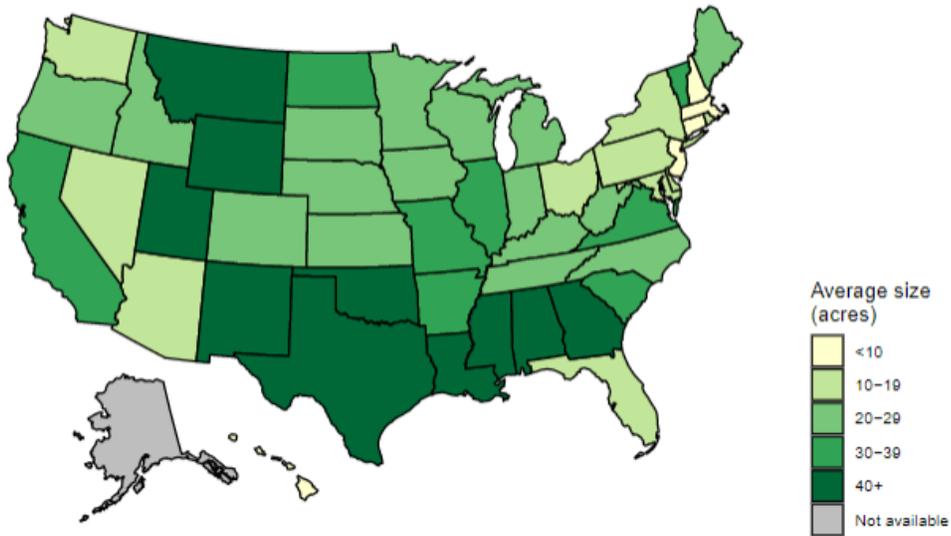


677

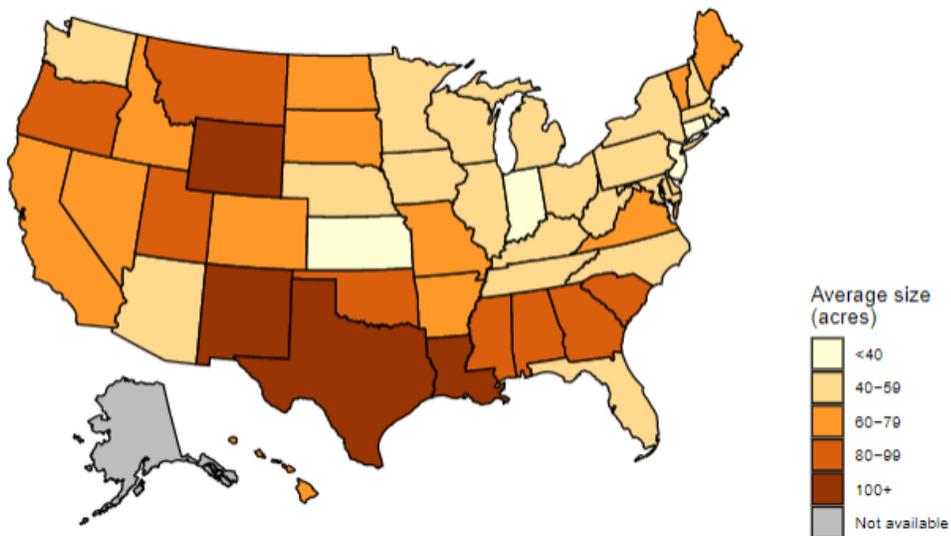
678 Figure 3. Distribution of A.) number of family forest ownerships and B.) family forest acreage
 679 by size of forest holdings, U.S., 2006 (Butler 2008), 2013 (Butler et al. 2016b), and 2018 (Butler
 680 et al. 2020).

681

A. Minimum of 1+ acres of forestland



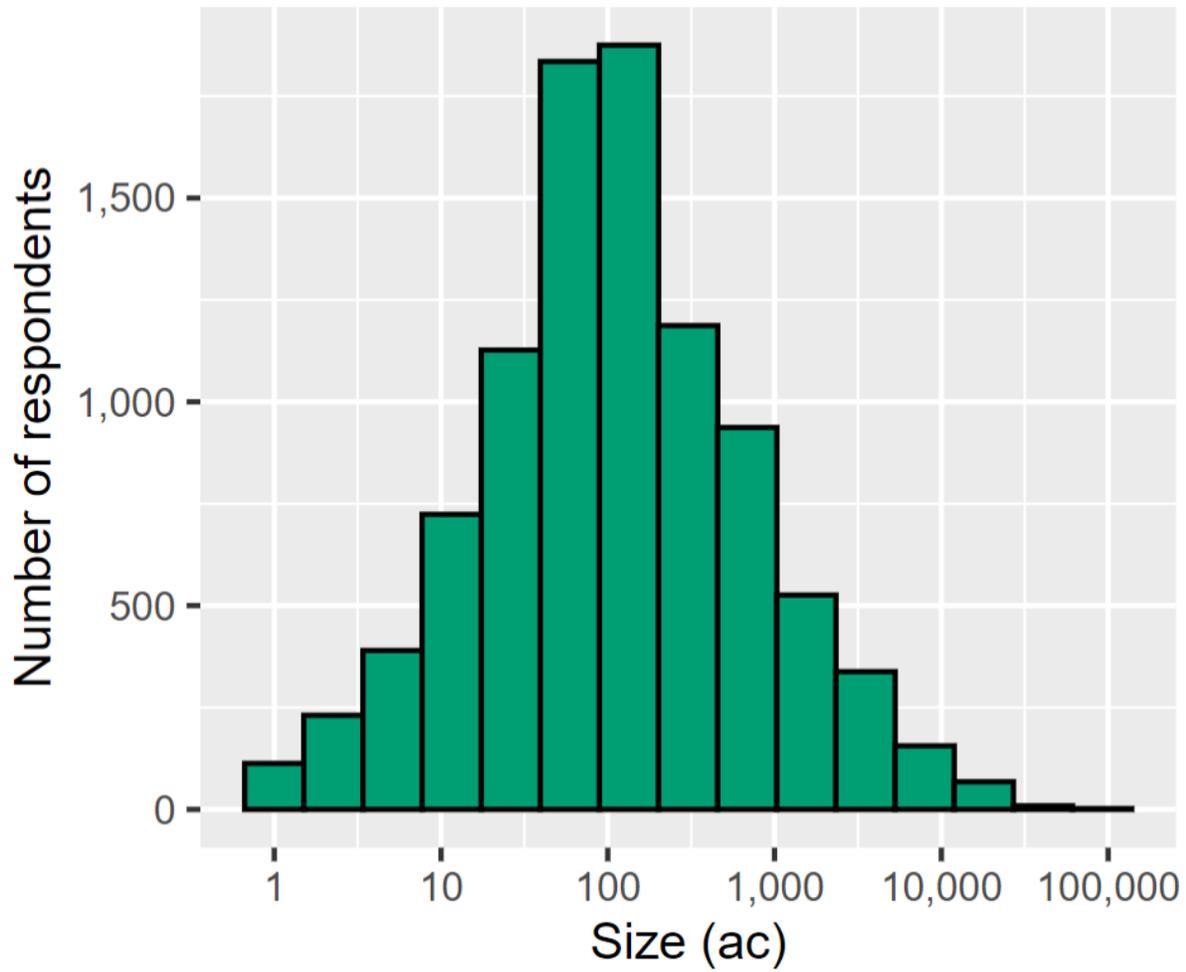
B. Minimum of 10+ acres of forestland



682

683 Figure 4. Mean size of family forest holdings for family forest ownerships with A) 1+ and B)
684 10+ acres of forestland, U.S., 2018 (Butler et al. 2020).

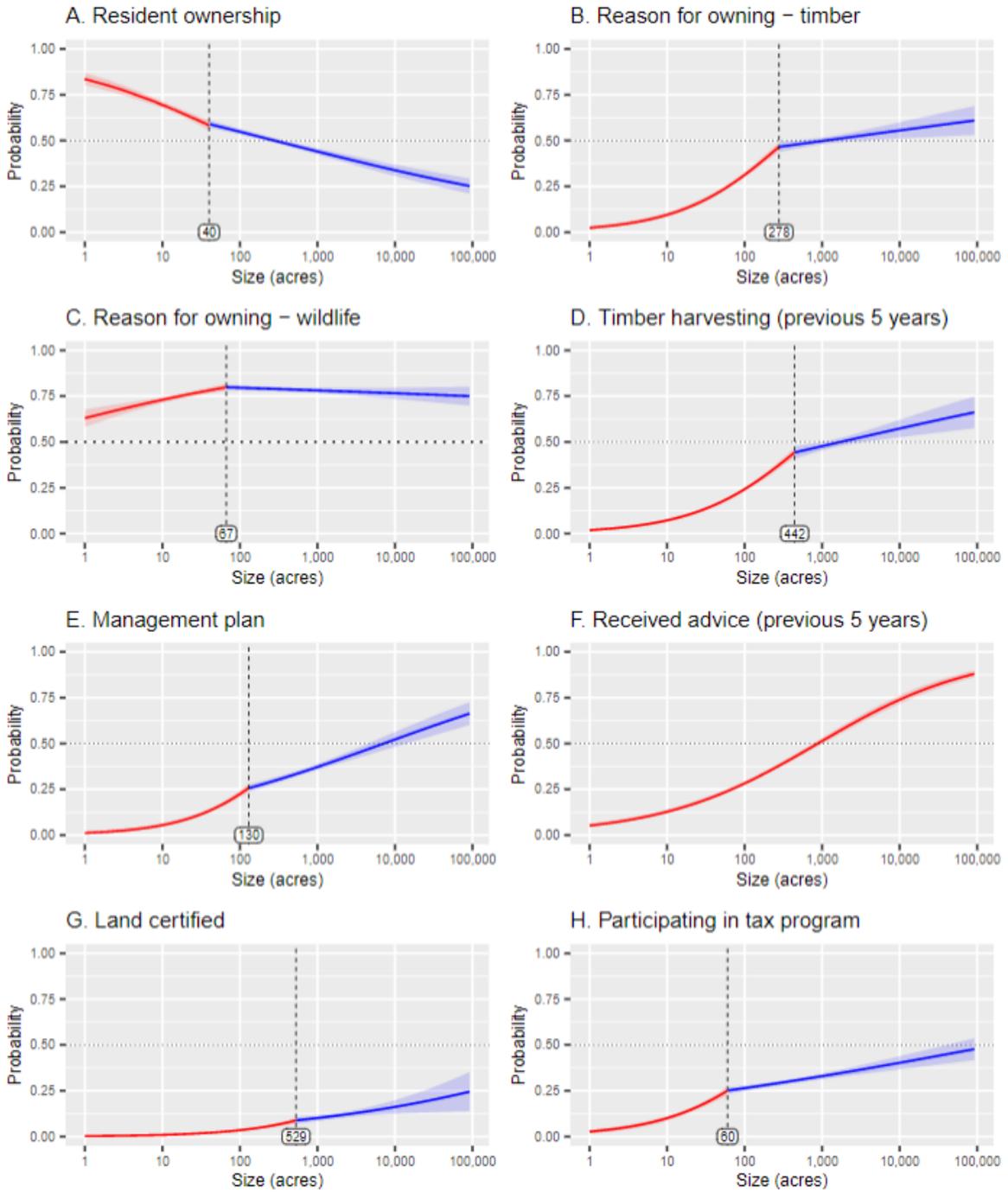
685



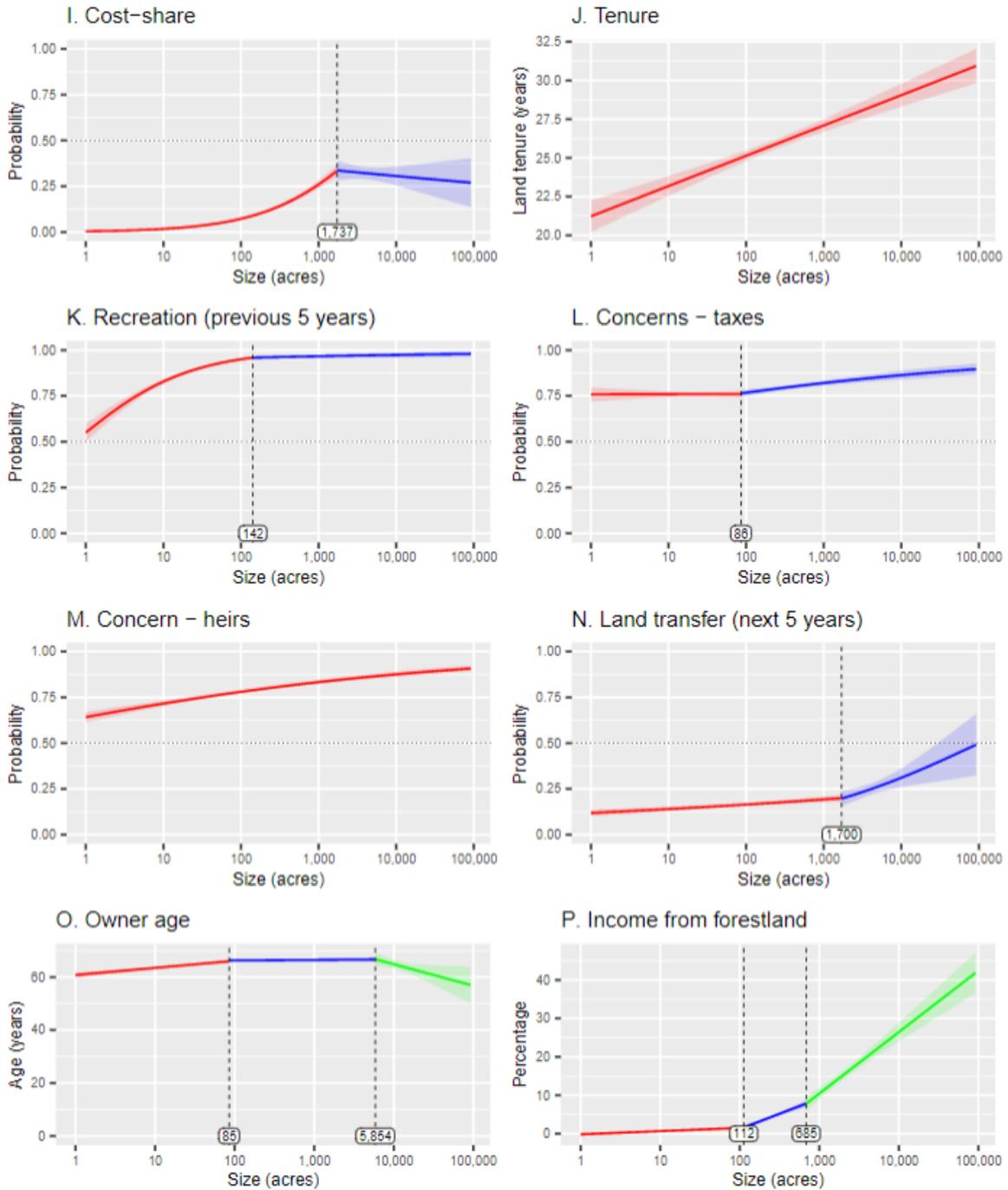
686

687 Figure 5. Number of family forest ownership respondents to the USDA Forest Service, National
 688 Woodland Owner Survey by size of forest holdings, U.S., 2018.

689



690



691

692 Figure 6. Predicted values for segmented regression models relating size of family forest
 693 holdings and selected variables, U.S., 2018. The x-axes are on a log scale, ribbons depict 95%
 694 confidence intervals, colors represent different segments, vertical dashed lines are breakpoints
 695 labelled with the breakpoint values, and horizontal dotted lines, where applicable, are
 696 probabilities = 0.5.

697

698 **Supplemental Materials**

699 *Appendix I.* Breakpoints for segmented regression models relating size of family forest holdings
 700 and selected variables from the USDA Forest Service, National Woodland Owner Survey, U.S.,
 701 2018.

Variable	Breakpoint number	Breakpoint value	Standard error	p-value
HOME	1	3.69	0.47	<0.001
OBJ_TIMBER	1	5.63	0.15	<0.001
OBJ_WILDLIFE	1	4.2	0.34	<0.001
HARVEST	1	6.09	0.2	<0.001
PLAN	1	4.87	0.2	<0.001
ADVICE*	--	--	--	--
CERTIFIED	1	6.27	0.47	0.001
TAX_PROGRAM	1	4.10	0.18	<0.001
COST_SHARE	1	7.46	0.20	<0.001
TENURE*	--	--	--	--
REC	1	4.96	0.32	<0.001
CNC_TAXES	1	4.45	0.57	0.001
CNC_HEIRS*	--	--	--	--
TRANSFER	1	7.44	0.59	0.007
AGE	1	4.44	0.31	<0.001
AGE	2	8.67	0.27	0.03
FOREST_INCOME	1	4.72	0.21	<0.001
FOREST_INCOME	2	6.53	0.21	0.003

* No breakpoints detected.

702

703

704 **Appendix II.** Summaries of regression models relating size of family forest holdings and selected
 705 variables from the USDA Forest Service, National Woodland Owner Survey, U.S., 2018.

Model	Type*	Range for LN_ACRES		Intercept coefficient		LN_ACRES coefficient		p-value**	R ² ***
		Min. (≥)	Max. (<)	Value	Standard error	Value	Standard error		
HOME_1	Logistic	--	3.69	1.63	0.13	-0.35	0.04	<0.001	0.019
HOME_2	Logistic	3.69	--	1.06	0.11	-0.19	0.02	<0.001	0.012
OBJ_TIMBER_1	Logistic	--	5.63	-3.72	0.13	0.64	0.03	<0.001	0.076
OBJ_TIMBER_2	Logistic	5.63	--	-0.70	0.26	0.10	0.04	0.006	0.002
OBJ_WILDLIFE_1	Logistic	--	4.20	0.53	0.10	0.20	0.03	<0.001	0.008
OBJ_WILDLIFE_2	Logistic	4.20	--	1.54	0.15	-0.04	0.02	0.118	<0.001
HARVEST_1	Logistic	--	6.09	-3.96	0.13	0.61	0.03	<0.001	0.078
HARVEST_2	Logistic	6.09	--	-1.26	0.34	0.17	0.05	<0.001	0.005
PLAN_1	Logistic	--	4.87	-4.46	0.20	0.70	0.05	<0.001	0.060
PLAN_2	Logistic	4.87	--	-2.36	0.18	0.27	0.03	<0.001	0.017
ADVICE_1	Logistic	--	--	-2.91	0.08	0.43	0.01	<0.001	0.095
CERTIFIED_1	Logistic	--	6.27	-6.05	0.31	0.59	0.06	<0.001	0.051
CERTIFIED_2	Logistic	6.27	--	-3.80	0.57	0.23	0.07	0.002	0.007
TAX_PROGRAM_1	Logistic	--	4.10	-3.60	0.20	0.61	0.06	<0.001	0.042
TAX_PROGRAM_2	Logistic	4.10	--	-1.65	0.13	0.14	0.02	<0.001	0.006
COST_SHARE_1	Logistic	--	7.46	-5.56	0.17	0.65	0.03	<0.001	0.105
COST_SHARE_2	Logistic	7.46	--	-0.08	0.90	-0.08	0.11	0.460	<0.001
TENURE_1	OLS	--	--	21.23	0.52	0.85	0.09	<0.001	0.009
REC_1	Logistic	--	4.96	0.20	0.10	0.6	0.03	<0.001	0.082
REC_2	Logistic	4.96	--	2.62	0.49	0.11	0.08	0.162	0.002
CNC_TAXES_1	Logistic	--	4.45	1.14	0.11	0	0.03	0.944	<0.001
CNC_TAXES_2	Logistic	4.45	--	0.54	0.18	0.14	0.03	<0.001	0.005
CNC_HEIRS_1	Logistic	--	--	0.58	0.06	0.15	0.01	<0.001	0.012
TRANSFER_1	OLS	--	7.44	-2.00	0.09	0.08	0.02	<0.001	0.002
TRANSFER_2	OLS	7.44	--	-3.95	0.92	0.34	0.11	0.003	0.012
AGE_1	OLS	--	4.44	60.8	0.54	1.17	0.16	<0.001	0.012
AGE_2	OLS	4.44	8.67	65.88	0.92	0.09	0.15	0.560	<0.001
AGE_3	Logistic	8.67	--	97.36	14.94	-3.53	1.61	0.029	0.003
INCOME_1	OLS	4.72	--	-0.17	0.21	0.36	0.06	<0.001	0.007
INCOME_2	OLS	--	4.72	-14.68	2.26	3.45	0.41	<0.001	0.024
INCOME_3	OLS	4.72	--	-37.57	5.20	6.95	0.68	<0.001	0.063

706 * OLS = ordinary least squares

707 ** p-values are for the coefficient of the variable of interest in each model.

708 ** For logistic models, the McFadden's pseudo-R² values are reported. For OLS models, the standard R²

709 values are reported.