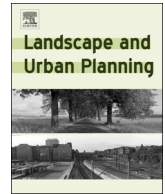




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## Research Note

## Longitudinal data on family forest owners: The US Forest Service's National Woodland Owner Survey

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## ABSTRACT

Although a rich history of scholarship exists on the attitudes, past behaviors, and behavioral intentions of family forest owners, little is known about how these social factors change over time. Furthermore, linking behavioral intentions with actual behaviors of family forest owners will require a longitudinal design that re-measures behaviors of the same respondents over time to match with earlier surveys of intention to behavior. Previous attempts to measure behavioral and attitudinal change over time have been largely opportunistic and have not followed a true longitudinal study design. Additionally, previous attempts to measure change in family forest owner behavior have been limited in geographic scope. This research note briefly describes data management considerations for analyzing the U.S. Forest Service's National Woodland Owner Survey (NWOS) longitudinally for the past three iterations of the survey and describes the potential changes in family forest ownership to demonstrate the approach. Forty-one percent of commonly-sampled points remained in the same ownership type between the first two survey iterations, and interesting shifts in ownership type were observed. For example, 30% of resampled locations changed ownership between the two survey iterations. As the NWOS continues to be implemented, the value of this longitudinal dataset will continue increasing, even as respondents are lost to follow-up, or as land changes hands.

## 1. Introduction

Understanding family forest owner (FFO) management behaviors is imperative to anticipate potential changes to forests and the many benefits they provide. This ownership group represents 36% of United States' forestland and over 11 million families, individuals, trusts, and estates (Butler, Hewes, Dickinson, Andrejczyk, Butler, & Markowski-Lindsay, 2016a). Although a rich history of scholarship exists on the attitudes, past behaviors, and behavioral intentions of family forest owners (Silver, Leahy, Kittredge, Noblet, & Weiskittel, 2015), little is known about how these social factors change over time. Furthermore, linking behavioral intentions with actual behaviors of family forest owners will require a longitudinal design that re-measures behaviors to match with earlier surveys of intentions to perform specific behaviors (Belin, Kittredge, Stevens, & D., Dennis, C., 2005). A longitudinal analysis of this type could help determine if landowner intentions actually lead to behaviors and the factors that are correlated with these activities.

The defining characteristic of any longitudinal study is that the

same individuals are measured over time (Diggle, Heagerty, Liang, & Zeger, 2002) or that multiple observations of the same subject can be ordered by a time parameter (Weiss, 2005). Longitudinal datasets are inherently multivariate (i.e., more than one response per subject) and are considered a particular form of repeated measures data. The alternative to using a longitudinal design, common in studies of human attitudes and behavior, is a cross-sectional design, which collects a univariate response and covariates on any number of subjects. The common data collection (and thus analytical) challenges with longitudinal design are missing data from subjects leaving the study and the non-constant variance (Weiss, 2005), however there are statistical tools to correct for both of these issues. The minimum and ideal attributes of a longitudinal study are: 1) Subjects must be the same in repeated measurements or replaced by subjects within the study population; 2) Measurements (or survey instruments) must remain the same over time; and 3) The time interval between measurements must be fairly consistent (Diggle et al. 2002). It is important to note that even when the measurements/questions remain the same, there is still the possibility that the same constructs may not be valid as political and social

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contexts change (Pitts, West, & Tein, 1996).

Previous attempts to measure change of FFO behaviors over time have been largely opportunistic or have not followed a true longitudinal study design, relying instead on comparisons of cross-sectional surveys which may lack consistency. Although these opportunistic studies have contributed important knowledge on the current status of FFOs, little is known about how family forest ownership and management behaviors change over time. In New York, Rosen (1995) re-sampled the same non-industrial private forest landowners in 1983 and 1992 using the same survey instrument, an example of a longitudinal design, but without subsequent re-sampling after 1992. The response rate in 1992 contained 32% of the original respondents for a total of 342 re-measured forest landowners. From this study, Rosen learned that attitudes towards harvesting had deteriorated over time. In a ten-year assessment of the Forest Stewardship Program, Jennings and McGill (2005) used a previously implemented questionnaire, but did not re-measure the same landowners, restricting the ability to control for within-subject variability. Finally, Egan and Jones (1995) re-sampled the same landowners 8-months after an initial survey and found troubling inconsistencies between what was reported first and at re-measurement with respect to a timber harvest. This study did not capture the time horizon more representative of forest management decisions, which typically occur across annual or multi-year scales, further supporting the need for longitudinal designs that cover longer timespans.

The National Woodland Owner Survey (NWOS) is a national-scale measurement of private forest owners, implemented by the U.S. Forest Service, Forest Inventory and Analysis program, an institution that can maintain long-term data without as much disruption from funding cycles and personnel turnover as is commonly seen in colleges and universities. The NWOS asks questions about landowner attitudes, intentions, and behaviors and is thus a good source of data to understand FFO behavior over time. This research note describes necessary data management considerations before analyzing the NWOS longitudinally and describes selected broad changes in family forest ownership between the 2002–2006, 2011–2013, and 2017–2018 iterations of the survey.

## 2. Methods

The NWOS uses a probability proportional to size sample design built upon the FIA sampling grid (Dickinson & Butler, 2013). A hexagonal grid, with cells approximately 2428 ha in size, was created and within each a grid cell a sampling point was randomly selected. Remote sensing and ground truthing were used to determine if the point was forested and, for the forested points, the ownership of record was determined from public property tax records. The private forest ownerships thus identified formed the sample for the NWOS and a survey was mailed to this sample of private forest ownerships.

**Table 1**

Key used to classify owners over time, with sample sizes for Cycle 4-5, Cycle 5-6, and Cycle 4-6. The sample size indicates a commonly-sampled point, not an actual survey respondent.

Group	Description	Commonality between cycles					
		Cycle 4-5		Cycle 5-6		Cycle 4-6	
		Sample size	Category percent	Sample size	Category percent	Sample size	Category percent
1	Same owner	3877	41%	1955	53%	1097	30%
2	Similar owner: possible typo or missing information	508	5%	310	8%	244	7%
3	Some owners are the same	1091	12%	310	8%	374	10%
4	Clear familial shift	637	7%	184	5%	309	8%
5	Company to an individual or vice versa	141	2%	42	1%	66	2%
6	Individual to a trust or estate or vice versa	190	2%	82	2%	73	2%
7	Shift to “care of”	27	< 1%	8	< 1%	2	< 1%
15	No apparent relationship	2705	29%	768	21%	1494	41%
	Total	9444	3659	3659			

We used the 2002–2006, 2011–2013, and preliminary numbers from the 2017–2018 (annual surveys aggregated into one database for each time period) iterations of the NWOS to determine if there were common ownerships that had been sent the survey during all three time periods. Responses are those ownerships that have mailed back a completed NWOS. We call these NWOS iterations “Cycle 4–6” because they are the 4th, 5th, and 6th national forest landowner surveys. Cycles 1–3 were published in 1958, 1982, and 1996 (Josephson & McGuire, 1958; Birch, 1996; Birch, Lewis, & Kaiser, 1982). During cycles 4, 5 and 6, the survey instruments were more similar than they have been in previous iterations, thus facilitating longitudinal analyses. Question wording did not change, but some questions were dropped due to significant item non-response. Those questions are thus ineligible for longitudinal analyses. For a comparison of common questions between cycles 4 and 5, see Butler, Hewes, Dickinson, Andrejczyk, Butler, & Markowski-Lindsay, 2016b; because Cycle 6 is still ongoing and remains unpublished, survey instrument comparisons can be done with publicly provided survey information (. Forest Inventory and Analysis National Woodland Owner Survey Program. USDA Forest Service, Accessed July 2018, 2018). Cycles 1, 2, and 3 used questionnaires whose different question wording makes them problematic for inclusion in a longitudinal analysis. Importantly, the same points were used for the first time in cycles 4–6.

In the three most recent iterations, owners identified were assigned an owner number to uniquely identify survey responses. During cycles 5 and 6, if there was a direct match with the owner name from cycle 4, the same owner number was used. We used a similarity index to code and categorize owners that may have been the same in both cycles, detailed in the next section. This index was necessary due to different data recording quality among field crews. If any discrepancies were detected, a different owner number was assigned.

For more information on how FIA plots are installed and sampled, see Bechtold and Patterson (2005). For more information on the sampling procedures for the NWOS sample points, see Butler (2008) and Butler et al. (2016a), respectively.

## 3. Results

There were 9444 commonly sampled points between the Cycle 4 (2002–2006) and Cycle 5 (2011–2013) survey and 3659 commonly sampled points between the Cycle 5 and Cycle 6 (2017–2018) and also between the Cycle 4 and Cycle 6 surveys. These numbers represent the potential for collecting responses from the same owners over time, *but does not represent respondents* for which there is data on demographics, attitudes, intentions, and behaviors. These points had to have remained forested and remained privately-owned in both cycles but may have switched into different sub-types of private ownership (e.g. from individual to corporation or from corporation to conservation group). Of

**Table 2**

Response matrix for the commonly-sampled points ( $n = 9444$ ) for two iterations of the National Woodland Owner Survey: Cycle 4 (2002–2006) and Cycle 5 (2011–2013). The 2017–2018 cycle is still ongoing.

		Cycle 5		
		Unknown/ Undeliverable	Non- respondents	Respondents
Cycle 4	Unknown/ Undeliverable	196	821	655
	Non-respondents	340	2166	1287
	Respondents	240	1419	2320

the 9444 common points in Cycle 4 and 5, 41% of the ownerships had remained the same between cycles while 29% had no apparent relationship as determined by comparing the owner names listed and determining that they did not share a first name or a last name (Table 1). Twelve percent of commonly-sampled points included some similar owners, but also an owner change between cycles. For example, the Cycle 4 owner may have been listed as John Smith and the Cycle 5 owner listed as John Smith and Andrew Roberts. Although less common, some plots transitioned between individual owners and companies, trusts, or estates. Of the 3659 common points in Cycle 5 and 6, just over half remained with the same owner while between Cycles 4 and 6 about a third remained the same. The number of plots with a similar owner or some similar owners was about 17% between cycles 5 and 6, and cycles 4 and 6 (Table 1).

However, only a portion of these commonly sampled points correspond to returned surveys. After non-respondents and undeliverable surveys across both survey cycles were removed, the total number of returned surveys on the commonly sampled points was 2320 (Table 2). Of the actual NWOS sample-point respondents from both Cycle 4 and Cycle 5, 59% were the same owner, using a direct match of names (Table 3), 18% higher than the commonly sampled point analysis. Approximately 15% of respondents from both cycles had no apparent relationship, based on our similarity key. This 15% reflects half the percentage that had no apparent relationship when looking only at commonly sampled points (not sample-point respondents). The remainder of the dynamic key categories were similar between commonly-sampled points and commonly-sampled respondents. Responses for the 2017–2018 are ongoing and thus are not included in this Table.

#### 4. Discussion and conclusions

Two ways to conceptualize changes in FFO land over time are: how owners change behavior and how parcels change ownership. It is important to know how ownership changes at a particular place on the ground to better understand the effects of FFO behavior on the forest overall as a function of time. For example, the common point data indicates that over a 5–7-year period (slight range due to sampling design

**Table 3**

Commonly-sampled point respondents, Cycle 4 (2002–2006) – Cycle 5 (2011–2013), classified by similarity key.

Group	Description	Percent	Common ownerships
1	Same owner	59	1369
2	Similar owner: possible typo or missing information	2	37
3	Some owners are the same	16	377
4	Clear familial shift	5	108
5	Company to an individual	1	33
6	Individual to a trust or estate	2	44
7	Shift to “care of”	< 1	8
15	No apparent relationship	15	344

of the NWOS), one-third of forested sample points may have undergone a change in ownership. When considering the latest (Cycle 6) data, over 40% of parcels may have undergone a change in ownership. These new owners may have similar management objectives, but they might also take a very different approach to forest management. In addition, the transition of ownership itself, may trigger a change in management (e.g., harvest prior to selling) or land use.

It is equally important to understand how the same FFOs themselves change their intention and behavior over time. This requires re-measurement of the same owners over time owning the same parcel(s) of woodland. The NWOS keeps a record of when a specific location and a specific owner is sent a survey, and the same information is collected from respondents. This allows the survey to track both forest holdings and forest owners over time. By analyzing the parcels, regardless of there being the same owner at re-measurement, we can measure change in size of holding, and change in the demographics of various owners as the parcel is sold or inherited. By restricting the analysis to only those owners who are the same over time and using NWOS survey response data (accounting for some inconsistencies in who, specifically, is recorded as the landowner during field sampling), we can measure how FFOs may change their attitudes and behaviors as they grow older, or as personal circumstances change. Age is often a significant predictor in timber harvesting behavior (Silver et al., 2015, Butler, Butler, & Markowski-Lindsay, 2017).

This initial comparison revealed a few interesting trends with private ownerships. First, nearly 30% of commonly-sampled points changed hands between Cycle 4 and Cycle 5 (approximately 5–7 years), and over 40% changed hands between Cycle 4 and Cycle 6, based on the similarity key. This turnover can be compared with the tenure data collected by the NWOS, asking respondents “In what year did you, personally, acquire land in < STATE > ?” to better understand land ownership change over time. Potential questions to be explored include the likelihood that larger ownerships are more likely to gain or lose land (higher turnover) or that larger ownerships are less likely to respond to the survey. While we do not have evidence of this yet, it would be interesting to test differences in small and large forest owners over time. Of the commonly-sampled points that did respond to the survey in both Cycle 4 and Cycle 5, 59% were the same owner compared to only 41% of all sample points who were mailed a survey. This may indicate that having received and responded to a survey in the past makes you more likely to do in a future iteration or that owners who have owned the land longer are more likely to respond. Finally, the 19–21% of owners for whom one name appeared the same or where a clear familial shift was determined indicates a large proportion of owners who may face the challenges of inter-generational land transfer. However, there is a potential measurement error; field crews may have recorded one name in particular measurement period and two in the next measurement period or vice versa. Approximately 80% of all FFO land is over the age of 55 years old, or roughly 2.7 million family forest owners, and they will be facing decisions of future ownership and use of their land (Butler et al. 2016a, Markowski-Lindsay, Catanzaro, Milman, & Kittredge, 2016). Longitudinal studies of these owners could help better understand the connection between intentions and estate plans for their land and actual outcomes (Markowski-Lindsay et al., 2018). It is important to note that the numbers presented here are not weighted, and thus do not reflect population estimates.

If only the most conservative coding category (1 = same owner) were used, the sample size of 1369 is still large enough for powerful statistical analysis, assuming item non-response is relatively minimal for the questions of interest. Although a paired *t*-test or Wilcoxon matched pairs test can be used to look at two points in time, the most common analytical tool for behavioral longitudinal data is a linear mixed effects regression (LMER) analysis (Hedeker & Gibbons, 2006). This tool works best with more than two data collection waves (Singer & Willett, 2003). Thus, future research could take Cycle 6 data (2017–2019) and compare these data with Cycles 4 and 5. LMER

extends traditional multiple regression by including individual-level terms known as random effects. These random effects capture the variation among individual change curves. The inferential goal of an LMER analysis is to provide insight into within-subject and between-subject variation. There are also generalized estimation equations (Chaganty, 1997) and random coefficient analysis, which perform similarly on continuous outcome variables, but with unpredictable results when the outcome variable is dichotomous (Twisk, 2004). Structural equation modelling is an option for longitudinal data analysis (Farrell, 1994), but generally the LMER approach has gained widespread use in the last few decades.

A few limitations are important to future longitudinal work with the NWOS responses. First, as mentioned above, field crew error when recording owner names may limit the ability to draw conclusions about clear familial shifts. Second, forest/non-forest and public/private transitions cannot be tracked at the parcel level. Third, although there may be useful analyses done with the commonly-sampled plot point data, based on the key in Table 1, the ability to analyze the NWOS longitudinally will still depend on an adequate response rate to the survey, specifically from landowners on these commonly-sampled plots.

The ability to measure change over time on FFO land will provide insight into landscape-challenges like parcellation, lack of coordinated timber harvesting, and provision of ecosystem benefits. The landscape-scale phenomena described throughout this special issue provides a context for future work tracking how the same landowners may change over time, and for observing what happens when a family forest parcel changes ownership. Moreover, the additional ability to track specific owners over time will advance knowledge on the link between behavioral intentions and behaviors (Ajzen, 1991) in the natural resource domain. It will also increase knowledge of intergenerational land transfer and how individual attitudes towards forested land changes over time. As the NWOS continues to be implemented and the dataset lengthens, the value of this longitudinal dataset will continue increasing, even as respondents are lost to follow-up, or as land changes hands.

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