

**Ecopsychology**

Vol. 00 No. 00 (Month 2026)

DOI: 10.1177/19429347261477611

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# Landowners' Engagement with Forest Land Predicts Improved Affect: An Ecological Momentary Assessment Study in the Great Northwoods Region, USA

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## Abstract

*Although forest-based ecosystem services are well-documented, limited research has examined the role of forest ownership in human well-being. We conducted an ecological momentary assessment (EMA) of evaluative and experienced subjective well-being (i.e., affect) among private landowners in the Great Northwoods region of Michigan and Wisconsin, USA. The amount of land people owned, whether that land was forested, and how often and in what ways respondents engaged with their land was not related to life satisfaction or eudaimonic well-being (i.e., worth and meaningfulness of life). In contrast, landowners who engaged with their land and had visited, recreated, or thought about their land in the 24-h period before assessment had increased positive affect (i.e., "happiness"). Negative affect (specifically "depression") was found to be negatively related to land engagement. These results suggest that experienced measures of subjective well-being, when included in EMAs, have potential for illuminating the relation between land ownership, land use, and human well-being. Key Words: Ecological momentary assessment—Forest landowners—Landownership—Subjective well-being.*

One of the primary justifications for owning, protecting, managing (and, for that matter, researching) forest land is to improve human welfare, whether through the production of wood and other forest products specifically or the provision of ecosystem services more broadly (e.g., Nyland, 2007; Smith, Larson, Kelty, & Ashton, 1997). Although the economic and environmental benefits of forests have been a consistent focus of the forestry profession throughout history (e.g., Caputo, 2012), there has been little research emphasis on formally linking forest landowner engagement to measures of human well-being. Without understanding this critical linkage, forest managers are limited in their ability to deliberately conserve, manage, or otherwise steward forest resources to benefit private landowners.

Measures of human well-being are broadly categorized as objective or subjective (Gaspar, 2007; Maddux, 2017). Objective well-being indicators are those that can be seen, measured, or assessed externally to a subject's own perspective (i.e., "nonfeeling" measures). The most commonly used indicators of objective well-being have traditionally included economic measures, predicated on the premise that willingness-to-pay for a good or service reflects the utility of that good or service to the recipient (i.e., utility maximization theory). This partially explains the historical emphasis on forests as sources of commodities. Ecosystem services research originated in economic frameworks but has since moved beyond simple commodification and economic valuation (Muradian & Gómez-Baggethun, 2021). The field has largely retained its emphasis on objective measures of well-being, however focusing on directly measuring the flow of goods or services to beneficiaries (e.g., Beier, Caputo, & Groffman, 2015; Caputo et al., 2016; Caputo & Butler,

2017; López-Hoffman et al., 2014; Renard, Rhemtull, & Bennett, 2015; Wainger & Mazzotta, 2011).

In contrast to objective well-being, subjective well-being research refers to methods and instruments aimed at understanding humans' subjective experience of their own well-being. There are many dimensions of subjective well-being, including both evaluative and experienced measures (Maddux, 2017). Evaluative measures require respondents to cognitively assess the overall quality of their lives. Experienced measures or affect, by contrast, capture visceral and experiential positive and negative feelings or emotions, such as excitement, enthusiasm, and pride (positive affect) and fear, nervousness, and distress (negative affect). Diener (2000, 1984) introduced the influential tripartite model of subjective well-being, consisting of life satisfaction (an evaluative measure) and positive and negative affect (experienced measures). This successful framework is sometimes treated as being synonymous with subjective well-being as a whole or even measuring the totality of happiness<sup>1</sup> (e.g., Khalil, 2025), but, strictly speaking, it encompasses only the narrower dimension of hedonic well-being—in which well-being is defined in terms of pleasure, satisfaction, or enjoyment (Kahneman, Diener, & Schwarz, 1999; Ryan & Deci, 2001). Eudaimonic well-being is a separate and complementary dimension, concerned with the extent to which individuals' lives feel meaningful, purposeful, and worthwhile (Maddux, 2017; Ryan & Deci, 2001; Waterman, 1993). In addition to providing insights of its own, subjective well-being reliably corresponds with objective measures of well-being (Kahneman & Krueger, 2006; Lindberg, Swearingen, & White, 2020; OECD, 2013; Rendón et al., 2019).

Method to quantify evaluative and experienced measures of subjective well-being differs according to the response tendency and context specificity of these dimensions of subjective well-being. Life satisfaction and evaluative eudaimonic measures, for instance,

tend to correspond to the average, long-term well-being of an individual, whereas affect can change dynamically over time and in response to daily life events. As such, evaluative measures of life satisfaction are usually assessed retrospectively and upon reflection, while measures of affect are best assessed as close as possible to the experience(s) being evaluated to minimize effects of recall and reflection (Diener, 2000). The Organisation for Economic Cooperation and Development (OECD) has established several core measures of subjective well-being used widely in research and public policy, including a minimal set consisting of two evaluative measures (life satisfaction and eudaimonia) and one experienced measure. These questions have been used in the World Values Survey, the European Social Survey, the German Socio-Economic Panel, the British Household Panel Study, the Canadian General Social Survey, the Gallup World Poll, and the UK Office of National Statistics Annual Population Survey (OECD, 2013).

## Forests, Landowners, and Subjective Well-Being

Subjective well-being has been used as a theoretical lens to understand the relation between peoples' natural environments (i.e., nature) and their well-being, but much of this work has focused on urban environments, arboretums, parks, and other public and institutional spaces. Research on urban greening and access to nature has found numerous benefits of green space, including reduction in illicit behaviors (Rigolon, Banerjee, Gobster, Hadavi, & Stewart, 2021), improved test scores (Kuo, Browning, Sachdeva, Lee, & Westphal, 2018), and widespread improvements in physical health (Gailley, McElroy, Benmarhnia, & Bruckner, 2021; Li, 2018; Villani, 2025) such as decreased cortisol after riparian-area recreation (Opdahl, Demps, & Heath, 2021) and visiting urban parks (Gao et al., 2023). Partly because of this emphasis on urban areas, however, there has been a focus on *access* to green space or natural environments, regardless of the *ownership* of those resources. Even where research has been conducted in forests and other rural settings, studies have focused on access for a wide group of users and not necessarily just landowners (e.g., Výboštůk et al., 2024). The sociopolitical reality in the USA, however, is that most forest land is owned by private individuals and particularly families and individuals (Butler et al., 2021), so-called family forest owners or FFOs. A deeper understanding of how forest access and engagement relates to landowners' well-being could impact policy tools aimed at keeping forests as forests and maximizing landowner well-being as well as strategies for encouraging cross-boundary cooperation between FFOs and other private and public landowners. This understanding

<sup>1</sup>Several terms used in the SWB literature are used inconsistently. "Happiness" is an important example. Happiness has traditionally been used as an English-language translation of several Greek terms used in classical philosophy to refer to various dimensions of human well-being. In the modern SWB literature, it is sometimes used to refer exclusively to hedonic measures (as in Diener, 2000), sometimes to refer exclusively to life satisfaction, and sometimes to refer to SWB as a whole. In this article, we adopt a broad approach, using happiness to refer inclusively to all dimensions of human well-being and referencing specific dimensions where needed for greater clarity. When discussing our specific method and results, happiness generally refers to the positive affect measure.

would serve to support landowner well-being, ecological integrity, and the provision of public goods.

Several theories point to a plausible association between forest engagement by landowners and subjective well-being, given that forest owners may experience more frequent contact with—and connectedness to—nature. Two prevailing theories, attention restoration theory (ART; Kaplan & Kaplan, 1989) and stress reduction theory (SRT; Ulrich et al., 1991), provide insights into the role that frequent contact with nature may play in landowners' subjective well-being. ART and SRT forward unique hypotheses regarding the mechanisms underlying well-being but converge to predict that nature experiences enable expedient renewal of psychological resources (Kaplan, 1995). ART posits that, by capturing attention effortlessly and automatically, exposure to nature allows the cognitive capacity for directed attention to rest and replenish, thus minimizing mental fatigue (Kaplan & Kaplan, 1989), whereas SRT holds that contact with nature elicits rapid shifts toward positive emotions, accompanied by reductions in physiological stress (Ulrich et al., 1991). Regardless of the specific restorative pathway—attention restoration or stress reduction—both theories indicate that frequent contact with nature may yield greater subjective well-being.

Accumulating evidence over the past 30 years provides support for these theories (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Kondo, Jacoby, & South, 2018; McMahan & Estes, 2015). In an early lab-based test of SRT, for instance, Ulrich et al. (1991) found that participants who viewed images of natural, relative to urban, environments recovered more quickly and more completely from exposure to a stress-inducing video. Field experiments provide additional evidence that nature experiences can improve performance on attentional tasks (Berto, 2005), increase positive affect and decrease anger (Hartig, Evans, Jamner, Davis, & Gärling, 2003) and reduce anxiety and rumination associated with depression (Bratman, Hamilton, Hahn, Daily, & Gross, 2015).

Along with more frequent nature contact (i.e., land engagement), forest and other landowners may experience a deeper appreciation for and connection to the natural world—especially on land that they own and which provides a meaningful sense-of-place (Leahy & Lyons, 2021; Stedman, 2003). A majority of FFOs report having a strong emotional connection with their land (Butler et al., 2021). Past work indicates that the frequency and quality of an individual's nature experiences correspond with their sense of connection to nature (Hinds & Sparks, 2008). In turn, nature connectedness—a measure of an individual's levels of emotional connectedness to the natural world (Mayer & Frantz, 2004)—appears to predict subjective

well-being. A meta-analysis comprising more than 8500 participants, for example, shows that a strong sense of nature connectedness varies positively with several indicators of well-being, including vitality, positive affect, and life satisfaction (Capaldi, Dopko, & Zelenski, 2014).

In addition to benefiting from more frequent contact with and connection to nature, forest landowners may derive additional boosts to their well-being from ownership *in and of itself*. Land ownership confers valuable rights to landowners, including rights to extract, sell, and use timber or other natural resources (Nachmany & Hananel, 2019). Awareness of these potential resources could lead to landowners evaluating their own life more highly or having lower levels of negative affect (i.e., worry or anxiety) due to having a resource base as an economic safety net. Ownership *per se* may also be associated with nontangible benefits, for example, positive feelings associated with land stewardship (e.g., Asah, Blahna, & Ryan, 2012), terraphilia or landowners' love of their land (Beckley, 2025), and/or other relational values (e.g., Andabaka, Teslak, & Ficko, 2021). These benefits may result in increased positive affect, particularly feelings of happiness, pride, or self-efficacy (Lähdesmäki & Matilainen, 2014; Matilainen, Pohja-Mykrä, Lähdesmäki, & Kurki, 2017). Property theory gives insights into some additional ways in which property ownership itself confers benefits and contributes to well-being by creating opportunities for self-expression, personhood, and identity (Fagundes, 2017; Stewart, Charles, & Page, 2023). A related idea is that forest ownership provides an arena for exercising autonomy (Caputo, Ma, & Snyder, 2026a), which has been convincingly shown to be a primary psychological need (Ryan & Deci, 2001, 2017). Identity has also been linked to occupational activities—although not necessarily ownership—on larger landscapes, for example, being a farmer (Groth, Curtis, Mendham, & Toman, 2015) in general or a “good farmer” (McGuire, Morton, & Cast, 2013) specifically. In these cases, the land is the context in which identities are formed and maintained. Similarly, some forest landowners achieve feelings of satisfaction from the opportunities their land provides them to be a “good forest owner” (Andrejczyk, Butler, Tyrrell, & Langer, 2016; Bliss & Martin, 1989; Linné & Sallerberg, 2018).

## Study Objectives and Hypotheses

The primary objective of this study was to examine if and how forest and land engagement contributes to landowners' subjective well-being, as assessed through both experienced and evaluative measures. This is motivated by two underlying needs: (1) to provide additional data that support maintaining forests as such (rather

than, e.g., soft conversion to agriculture or hard conversion to urban development), particularly for FFOs, and (2) understand the link between landowners' land engagement activities and well-being to support professionals who help forest owners realize the benefits of their land through written management plans, estate planning, and other conservation or management behaviors. To meet this objective, we built upon a project that developed and validated an ecological momentary assessment (EMA) for FFOs in Massachusetts, USA (Huff & Kittredge, 2020). This project was referred to as the PING Project, after the individual momentary surveys (the "pings") used as the primary instruments.

EMAs are surveys, often brief, taken at the same time or very shortly after the events or phenomena being studied (Shiffman, Stone, & Hufford, 2008). They are typically repeated measures assessments. EMAs reduce measurement error and potential recall biases inherent to self-report retrospective survey method, which may impede measurement of actual behavior. These errors and biases may be particularly problematic for research into FFO behavior, since landowners are often spatially or temporally removed from their forests and may not even regularly think about them (Huff, Leahy, Kittredge, Noblet, & Weiskittel, 2017).

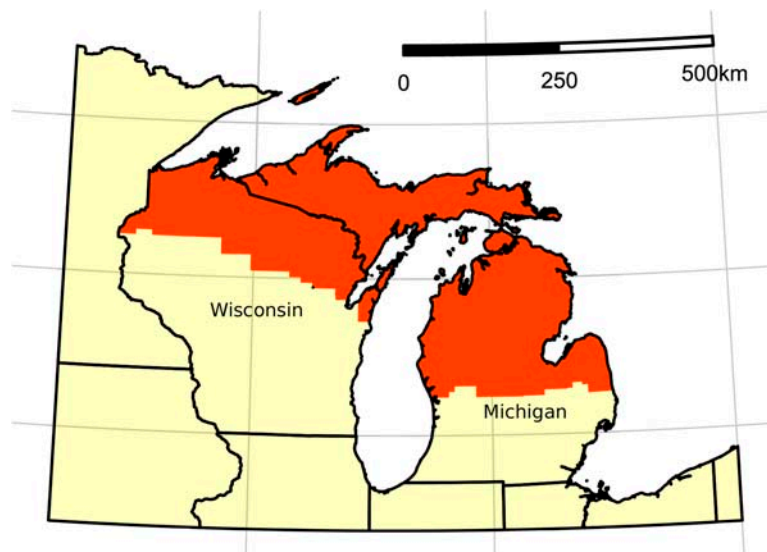
Huff and Kittredge (2020) generally concluded that EMAs had significant potential for use in forestry and landowner research and were suitable for further development. They found a high proportion of respondents were willing and able to respond in a timely

manner on a weekly time frame. Furthermore, their results suggested that landowners did in fact think about and engage in issues of land ownership within this temporal scale.

We believe that EMAs in general, and Huff and Kittredge's (2020) method specifically, have the potential for unraveling the relation between landowners' engagement activities and subjective well-being. This is particularly true for *experienced* measures, which must be measured within a short time after the engagement being tested, as they are more likely to show variability across events than evaluative measures. In fact, EMAs are equivalent to the experience-sample method that is expressly recommended for measuring affect (Diener, 2000; Kahneman, 1999).

## Method

This project was conducted within the Great Northwoods region (Fig. 1), which is comprised of the northernmost counties in the states of Michigan (55 counties) and Wisconsin (19 counties), USA. This region is characterized by private land ownership interspersed with federal, state, and, in Wisconsin, county-owned land, with forest land predominating. Specifically, more than 68% of this 74-county region is forested (Caputo, 2025). People in this region tend, overall, to support forest management practices that enhance ecosystem function and amenity enjoyment (e.g., environmental quality and recreation, respectively) as well as more utilitarian



**Fig. 1.** The Great Northwoods Region, USA, comprised of portions of the states of Michigan (55 counties) and Wisconsin (19 counties).



values (e.g., timber harvest and employment) (Floress, Vokoun, Huff, & Baker, 2019a).

## Participants and procedure and measures

We surveyed private, family landowners with at least 0.4 ha (1 acre) of land. This corresponds with other landowner surveys, such as the National Woodland Owner Survey (NWOS, Butler et al., 2021), and helps filter out landowners with small, urban, or otherwise developed parcels. We wanted to focus our analysis on landowners owning forests, farmland, lake shore, and other open green space. The corresponding sample frame was derived from multiple sources. Data from Michigan counties were obtained from Regrid (2024), a commercial vendor of aggregated, parcel-level spatial layers. Raw data contributing to these products come largely from individual land assessors; Regrid collects, aggregates, and standardizes the data before the point of sale. Data from Wisconsin were obtained directly from the county assessor offices. Although data from both sources were initially delivered as spatial layers, we took simple random samples from the attribute tables directly. All tables included a precalculated measure of parcel area, which was used to limit the sample to those meeting the minimum acreage criterion. Due to the nature of the data comprising the sample frame, individuals who did not own any land were not part of the study population. Research staff manually cleaned, deduplicated, and removed public and corporate ownerships (which were not part of the intended sample) to finalize the recruitment mailing list, which included 3351 family landowners owning at least 0.4 ha of land.

Recruitment postcards were mailed to all landowners on the final mailing list. The postcard briefly described the study objectives and instructed interested landowners to contact the authors through a provided email address. A financial incentive (a \$25 Visa or Amazon gift card) was offered to landowners who completed the 4-week study. Participating landowners were sent all additional instructions and surveys through the email address they provided in their initial response.

As in Huff and Kittredge (2020), data collection consisted of an initial baseline survey and a survey sent weekly for 4 weeks (i.e., the weekly “PINGs”). The initial survey contained two evaluative subjective well-being measures (life satisfaction and eudaimonic) from the OECD core question list (OECD, 2013; Table 1). Additionally, it included several background questions on land ownership and use, as well as demographics. These questions were based in part on the NWOS (Butler et al., 2021) and the original PING project in Huff and Kittredge (2020). The weekly surveys included three

**Table 1. Subjective Well-Being Measures. All Measures Were Identified as Core Questions in OECD (2013, Box.B.1 In Situ)**

| MEASURE                                                                                                                                                                                                                                                                                                                          | INCLUDED QUESTIONNAIRE |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Evaluative: life satisfaction                                                                                                                                                                                                                                                                                                    |                        |
| <i>The following question asks how satisfied you feel, on a scale from 0 to 10. Zero means you feel “not at all satisfied” and 10 means you feel “completely satisfied.” Overall, how satisfied are you with life as a whole these days?</i>                                                                                     | Baseline survey        |
| Evaluative: eudaimonic                                                                                                                                                                                                                                                                                                           |                        |
| <i>The following question asks how worthwhile you feel the things you do in your life are, on a scale from 0 to 10. Zero means you feel the things you do in your life are “not at all worthwhile,” and 10 means “completely worthwhile.” Overall, to what extent do you feel the things you do in your life are worthwhile?</i> | Baseline survey        |
| Affect, positive                                                                                                                                                                                                                                                                                                                 |                        |
| <i>The following questions ask about how you felt yesterday on a scale from 0 to 10. Zero means you did not experience the feeling “at all” yesterday while 10 means you experienced the feeling “all of the time” yesterday. Happy</i>                                                                                          | Weekly PINGs           |
| Affect, negative                                                                                                                                                                                                                                                                                                                 |                        |
| <i>The following questions ask about how you felt yesterday on a scale from 0 to 10. Zero means you did not experience the feeling “at all” yesterday while 10 means you experienced the feeling “all of the time” yesterday. Worried</i>                                                                                        | Weekly PINGs           |
| <i>The following questions ask about how you felt yesterday on a scale from 0 to 10. Zero means you did not experience the feeling “at all” yesterday while 10 means you experienced the feeling “all of the time” yesterday. Depressed</i>                                                                                      | Weekly PINGs           |

affect measures from the OECD core question list (Table 1) as well as questions on land use and engagement in the previous 24 h and the previous 48 h. These time frames were chosen to assess respondents’

engagement with their land during a period close in time to the point at which the affect questions were answered. All surveys were designed and administered through Qualtrics. Surveys were generally sent on Mondays and participants were asked to fill out the survey within 3 days of receiving the link in whatever manner (e.g., smartphone or computer) was most accessible. Surveys were not excluded if they were returned late, however. The recruitment postcards and survey instruments are included in Supplementary Data S1.

The data collection period included two rounds, the first between June and September, 2023, and the second between September and November, 2023. In both rounds, the same process was repeated; postcards were mailed to the recruitment mailing list, and questionnaires, baseline as well as weekly PINGs, were administered to willing respondents by email.

Data were initially analyzed using descriptive summary statistics as well as several models to examine relations between land and landowner attributes, land engagement, and subjective well-being. Two generalized linear models (GLMs) with the Gaussian distribution and identity link function (i.e., linear regression models) were also fit to predict the two evaluative subjective well-being measures based on size-of-land-holdings (log transformed), age, sex, whether landowners live on their land, whether landowners own forest land, whether landowners depend on their land for critical resources, what landowners primarily do on their land, seasonality of usage, and date as a temporal covariate. Forest landowner attributes were identified as being of potential predictive value based on the family forest landowner literature (e.g., Butler, Butler, & Floress, 2023; Floress et al., 2019b) as well as Huff and Kittredge (2020). Demographic factors were identified as being of importance based on the subjective well-being literature (e.g., González Gutiérrez, Jiménez, Hernández, & Puente, 2005; Inglehart, 2002; Mewafarosh & Agarwal, 2022; Moghal & Khanam, 2013). McFadden's  $R^2$  and variance inflation factors (VIFs) were assessed as model diagnostics.

We fit three linear mixed-effect (LME) models to predict the three experienced well-being measures collected weekly. Respondent ID was included as a random effect variable to address the nonindependence of the data stemming from the repeated measures design. Landowners' engagement with their own land (specifically, visiting, recreation, and/or thinking about their land), whether that engagement was on forest land specifically, and survey response date were included as fixed effects variables. Interaction terms of land engagement activity on forest land use were included to test whether effects of land engagement were higher or lower on forest land specifically. Although one might expect a high degree of

correspondence between baseline life satisfaction or eudaimonic well-being and the affect measures, we did not include these measures from the initial survey as predictors in the LME models. The structural and causal relation between affect and life satisfaction is complex and unresolved; we therefore elected to use a conservative, *separate components* approach in the current study (Busseri, 2025). Coefficients of determination (i.e., pseudo- $R^2$  values) and VIF were calculated as fit statistics for the LME models. All analyses were done using R version 4.4.2 (R Core Team, 2024). LME models were fit using the "lmerTest" package version 3.1.3 (Kuznetsova, Brockhoff, & Christensen, 2017), with pseudo- $R^2$  statistics calculated using the "MuMIn" package version 1.48.11 (Bartoń, 2025). All code and outputs, as well as model coefficients, error terms, and diagnostics for statistical models, have been included in Supplementary Data S2. We used  $\alpha = 0.10$  as a criterion of statistical significance for all models and statistical tests. Although  $\alpha = 0.05$  may be more common in the clinical literature, the relative considerations for Type 1 and Type 2 errors are different in this case (e.g., Quinn & Keough, 2002). For many, if not most, clinical interventions, concerns for Type 1 errors are paramount and interventions are generally not supported without meeting a conservative criterion for statistical significance. In the current case, however, land ownership or engagement is not solely (or even primarily) valued for its direct effects on subjective well-being. Given the challenges facing conservation of private land (e.g., Butler et al., 2022), Type II errors carry nontrivial risks of their own. Regardless of the  $\alpha$  level selected, we followed best practices in directly reporting  $p$ -values in all cases (Johnson, 1999).

## Results

Two hundred and fifteen individuals signed up for the study and completed at least the initial baseline questionnaire (136 from round 1 and 79 from round 2) for a response rate of 6.4% at the beginning of the study. Two hundred and five respondents completed at least one of the weekly PINGs. One hundred and ninety-five respondents completed all four PINGs for a response rate of 5.8% at the end of the study. We compared demographics across rounds 1 and 2 (early and late responders), and there were no statistically significant differences between the two. A nonresponse minisurvey was mailed to a small sample of nonresponders from each round, but not enough responses were received to statistically compare these nonresponders with the original sample. The survey instruments and study plans were reviewed and approved by the Institutional Review Board at Michigan State University (STUDY00006383).

### Initial survey

Respondents to the baseline survey owned a mean size-of-land-holdings of 57.5 ha (standard deviation [SD] = 247.6 ha). The distribution of this variable was strongly skewed; however, the median size-of-land-holdings was 8.1 ha (Table 2). Sixty-nine percent of respondents had forest or woodland on their property. More than 80% visit their land year-round and more than 90% visit their land during at least three of four seasons. Most respondents are male (63.7%) and live on their land (73.1%). Respondents' most common reported form of land engagement is visiting their land (39.4%), followed by recreating on their land (34.9%) and finally by working their land (25.7%). A minority of landowners depend on their land for critical natural resources (19.9%). The mean age of respondents is 61.7 years of age (SD = 13.7 years).

Respondents report high life satisfaction and eudaimonic well-being, with respective means of 8.3 (SD = 1.4) and 8.4 (SD = 1.3) on the 11-point scale. The distribution in both cases is skewed toward the higher end of the scale, with few individuals reporting low levels of subjective well-being (See Supplementary Data S2).

The results of the GLM models provide no support for the hypothesis that size-of-land-holdings, land engagement, or owning

forest land are associated with higher subjective well-being in terms of the evaluative measures. The model predicts female landowners to score approximately one half point higher on the life satisfaction scale ( $p = 0.053$ ), but no other variables in either model are significant at the  $\alpha = 0.10$  significance level (see Supplementary Data S2 for complete results). Models generally demonstrated poor fit, with McFadden's  $R^2$  values  $< 0.075$ . There was no evidence of problematic multicollinearity, with all VIF values being below 2.0.

### Weekly PING surveys

Most respondents visited, recreated on, and/or thought about their land in the 24- and 48-h periods prior to responding to the weekly PINGs across the study period. The specific values differed only slightly between the two time periods (Table 3). Consequently, the 24-h period was used in parameterizing the subsequent model fitting (see below) to minimize the temporal distance between the activities and the survey window. In most cases (64.2%), landowners' activities occurred on or in relation to forest land.

Respondents reported high levels of positive affect, that is, happiness (mean = 8.0, SD = 1.6), and low levels of negative affect, that is, worry (mean = 2.6, SD = 2.4) and depression (mean = 1.3, SD = 2.1). These values remained relatively consistent in magnitude and variance throughout the study period (see Supplementary Data S2). As was expected, the baseline evaluative measures in the initial survey were positively correlated with each other and with the positive affect measure in the weekly PINGs and negatively correlated with the negative affect measures. In other words, satisfaction was positively

**Table 2. Baseline Survey Respondent Characteristics in the Great Northwoods Region of Wisconsin and Michigan, USA 2023 ( $n = 215$ )**

| VARIABLE                     | SUMMARY STATISTICS                                                           |
|------------------------------|------------------------------------------------------------------------------|
| Size-of-land-holdings        | Mean = 57.5 ha (SD = 247.6 ha);<br>median = 8.1 ha                           |
| Landowners have forest       | 69.3%                                                                        |
| # of seasons land is used    | 81.9% use land year-round; 92.1%<br>use land during three<br>or more seasons |
| Landowners reside on land    | 73.1%                                                                        |
| Land engagement              | 39.4% visit; 34.9% recreation;<br>25.7% working                              |
| Depend on land for resources | 19.9%                                                                        |
| Landowners are female        | 36.3%                                                                        |
| Age                          | Mean = 61.7 years (SD = 13.7 years);<br>median = 63.5 years                  |

SD, standard deviation.

**Table 3. Landowner Activities in the Great Northwoods Region of Wisconsin and Michigan, USA**

| VARIABLE                                               | PERCENT "YES" |
|--------------------------------------------------------|---------------|
| Respondents visited their land in the prior 24 h       | 60.2%         |
| Respondents recreated on their land in the prior 24 h  | 42.6%         |
| Respondents thought about their land in the prior 24 h | 63.5%         |
| Respondents visited their land in the prior 48 h       | 62.5%         |
| Respondents recreated on their land in the prior 48 h  | 44.4%         |
| Respondents thought about their land in the prior 48 h | 62.5%         |
| Respondents' activities were on forest land            | 64.2%         |

Results from an ecological momentary assessment ( $n = 798$ ). Data represent a repeated measures design; individual observations are not fully independent.

correlated with eudaimonic well-being ( $r = 0.507$ ) and happiness ( $r = 0.475$ ) and negatively correlated with worry ( $r = -0.383$ ) and depression ( $r = -0.302$ ). Eudaimonia was positively correlated with happiness ( $r = 0.370$ ) and negatively correlated with worry ( $r = -0.298$ ) and depression ( $r = -0.264$ ). Happiness was negatively correlated with worry ( $r = -0.473$ ) and depression ( $r = -0.423$ ). The two negative affect measures, worry and depression, were positively correlated ( $r = 0.556$ ). This was the strongest correspondence among them all.

The results of the LME models support the hypothesis that landowners' engagement with their land—and in particular with their *forest* land—is associated with higher subjective well-being. Happiness (Table 4) was positively associated with recreating on land in

the previous 24 h ( $\beta = 0.642$ ,  $p < 0.001$ ), visiting land in the previous 24 h ( $\beta = 0.320$ ,  $p = 0.082$ ), thinking about land in the previous 24 h ( $\beta = 0.325$ ,  $p = 0.052$ ), and those activities occurring on or in relation to their forest land ( $\beta = 0.445$ ,  $p = 0.037$ ). The magnitude of these effects is relatively modest, however, ranging from 0.32 to 0.64 points on the 11-point scale. Depression (Table 5), in contrast hand, was negatively correlated with visiting one's land in the previous 24 h ( $\beta = -0.551$ ,  $p = 0.033$ ); depression scores decreased by an average of 0.55 points on the 11-point scale when respondents had visited their land in the previous 24 h. No variables were significant in the case of the second negative affect measure, worry. Date was nonsignificant in all models, suggesting that affect did not change across the study period. Interaction terms were

**Table 4. Random and Fixed Effects Table, Results of a Linear Mixed Effects Model Predicting Positive Affect (i.e., "Happiness") of Private Land Landowners**

| GROUP            | NAME      | VARIANCE   | SD     |         |         |
|------------------|-----------|------------|--------|---------|---------|
| Random effects:  |           |            |        |         |         |
| Respondent       | Intercept | 1.261      | 1.123  |         |         |
| Residual         |           | 1.167      | 1.080  |         |         |
| VARIABLE         | ESTIMATE  | STD. ERROR | df     | T-VALUE | P       |
| Fixed effects:   |           |            |        |         |         |
| Intercept        | -35.990   | 31.84      | 256.41 | -1.130  | 0.259   |
| Date             | 0.002     | 0.00       | 256.45 | 1.358   | 0.176   |
| Visit24          | 0.320     | 0.18       | 720.89 | 1.743   | 0.082*  |
| Rec24            | 0.642     | 0.18       | 694.07 | 3.550   | <0.001* |
| Thought24        | 0.325     | 0.17       | 682.03 | 1.944   | 0.052*  |
| Forest           | 0.445     | 0.21       | 706.16 | 2.095   | 0.037*  |
| Visit24:forest   | -0.106    | 0.23       | 701.09 | -0.465  | 0.642   |
| Rec24:forest     | -0.329    | 0.22       | 683.31 | -1.463  | 0.144   |
| Thought24:forest | -0.257    | 0.21       | 670.13 | -1.203  | 0.229   |

Results based on landowners' land engagement activities on their land, whether activities occurred on or in relation to forest land, and interaction terms. Data represent the results of an ecological momentary assessment study in the Great Northwoods Region of Michigan and Wisconsin, USA ( $n = 742$ , # of subjects = 201). Fixed effects include date on which a weekly survey was taken (date), whether respondent visited their land in 24 h prior to taking a weekly survey (visit24), whether respondent recreated on their land in 24 h prior to taking a weekly survey (rec24), whether a respondent thought about their land in 24 h prior to taking a weekly survey (thought 24), and whether engagement activities occurred on or in relation to forest land.

\*Variables significant at the  $\alpha = 0.10$  significance level.

SD, standard deviation.



**Table 5. Random and Fixed Effects Table, Results of a Linear Mixed Effects Model Predicting Negative Affect (i.e., "Depression") of Private Land Landowners**

| GROUP            | NAME      | VARIANCE   | SD     |         |        |
|------------------|-----------|------------|--------|---------|--------|
| Random effects:  |           |            |        |         |        |
| Respondent       | Intercept | 1.915      | 1.384  |         |        |
| Residual         |           | 2.407      | 1.551  |         |        |
| VARIABLE         | ESTIMATE  | STD. ERROR | df     | T-VALUE | P      |
| Fixed effects:   |           |            |        |         |        |
| Intercept        | −32.609   | 41.444     | 238.11 | −0.787  | 0.432  |
| Date             | 0.002     | 0.002      | 238.12 | 0.832   | 0.406  |
| Visit24          | −0.551    | 0.258      | 727.98 | −2.136  | 0.033* |
| Rec24            | −0.360    | 0.254      | 709.15 | −1.421  | 0.156  |
| Thought24        | −0.110    | 0.235      | 698.80 | −0.471  | 0.638  |
| Forest           | −0.378    | 0.302      | 719.00 | −1.252  | 0.211  |
| Visit24:forest   | 0.138     | 0.323      | 717.28 | 0.427   | 0.670  |
| Rec24:forest     | 0.243     | 0.316      | 699.24 | 0.770   | 0.442  |
| Thought24:forest | 0.256     | 0.302      | 687.09 | 0.846   | 0.398  |

Results based on landowners' land engagement activities on their land, whether activities occurred on or in relation to forest land, and interaction terms. Data represent the results of an ecological momentary assessment study in the Great Northwoods Region of Michigan and Wisconsin, USA ( $n = 738$ , # of subjects = 200). Fixed effects include date on which a weekly survey was taken (date), whether respondent visited their land in 24 h prior to taking a weekly survey (visit24), whether respondent recreated on their land in 24 h prior to taking a weekly survey (rec24), whether a respondent thought about their land in 24 h prior to taking a weekly survey (thought 24), and whether engagement activities occurred on or in relation to forest land.

\* Variables significant at the  $\alpha = 0.10$  significance level.

nonsignificant. Overall model fit was poor, with the marginal  $R^2 < 0.05$  and the conditional  $R^2 < 0.55$  in all cases. The intraclass correlation values for the three models were between 0.44 and 0.52. The VIF values for the main effects were all under 3.0, suggesting a lack of problematic multicollinearity. Values of specific results, including output tables for both negative affect models, are available in Supplementary Data S2.

## Discussion

This study of landowner well-being found that landowners exhibit high baseline levels of life satisfaction and eudaimonic well-being, broadly similar to those exhibited by the population at large in terms of the same or equivalent scales (e.g., Diener, 2000; Helliwell et al., 2024; VanderWeele et al., 2025). However, size-of-

land-holding, land engagement, and owning forest land do not increase these long-term, evaluative measures of subjective well-being. In contrast, landowners *do* report increased happiness (i.e., increased positive affect) and reduced depression (i.e., decreased negative affect) when engaging with their forest and other land in the previous 24 h. This is consistent with prior literature which finds that access to and contact with nature corresponds to improved health and well-being (Hartig, Mitchell, de Vries, & Frumkin, 2014). Experimental work finds that even brief bouts of nature exposure can elicit affective shifts, including increases in positive emotions such as happiness (Hartig et al., 2003) and reductions in negative emotions such as rumination and depression (Bratman et al., 2015). There are several possible mechanisms, including both physiological and psychological ones. Physiological mechanisms include

positive nervous system functioning, increased immune functioning, cardiovascular health, and reduced levels of stress hormones (Antonelli et al., 2022; Doimo, Masiero, & Gatto, 2020). Among possible psychological mechanisms, one intriguing possibility is that engagement with nature increases well-being by inspiring awe (Luo, Wang, Gao, & Yuan, 2025). Linking to property theory, land ownership itself may additionally contribute to happiness and well-being through opportunities to develop or exercise one's self-expression or identity (Fagundes, 2017). It is possible that forested land, as compared with other land use types, is associated with leisure-based activities as opposed to "working the land" (which may be more common in agricultural contexts), and thus, forest land engagement may be rooted in amenity values that confer greater happiness. Furthermore, research is needed to more formally test this concept. Additional research could also parse the attributes of forested systems (e.g., tree density and tree species) to determine if nuanced elements of forests differentially impact landowner well-being measures. The overall magnitude of the effect of engaging with forest land specifically is relatively low in our study (<1 point on the 11-point happiness scale); however, the authors consider this notable given the low variance around the reported values. Even if distinctive and nonspurious, the extent to which this modest effect size is meaningful from a clinical perspective is difficult to state, as the OECD does not provide cross-domain benchmarks.

If we see significant relations between landowners' affect and engagement with their forest and other land, why then do we find no significant relations between land engagement and the evaluative measures—life satisfaction and eudaimonic well-being? Affect is a short-term measure, whereas life satisfaction and eudaimonic well-being are long-term and retrospective. Whereas it is likely that forest and land engagement objectively contribute to landowners' moods, it is possible, even likely, that this effect fades quickly and does not significantly contribute to their reasoned, retrospective assessment of their life satisfaction and worthiness. Although 20% of respondents reported in the baseline survey that they depend on their land for critical resources, the degree of that dependence is uncertain. For them—and especially for the 80% who do not rely on their land for critical resources—it is probable that other considerations such as landowners' family lives, social environments, and employment or personal finances are simply much greater determinants of life satisfaction, eudaimonia, and overall well-being (e.g., Dong et al., 2024; Helliwell et al., 2024; VanderWeele, 2017). Even more fundamentally, prior research shows that evaluative measures vary to only a small degree with an individual's life circumstances

(Diener, 2000; Maddux, 2017), being instead driven more by culture, personality, and individual characters—a so-called construal theory of happiness (Maddux, 2017). Evaluative measures are not strongly associated with wealth (Ryan & Deci, 2001; Tamberg et al., 2024) or age (Jebb, Morrison, Tay, & Diener, 2020). In common with our findings, *hedonic* well-being has been shown to be higher in women (Helliwell et al., 2024; Liao, Shaw, Chen, & Lin, 2025; Tamberg et al., 2024; Waterman, 1993). Even in the case of the experienced measures, where we did see statistically significant relations with land engagement, model fit was generally poor—suggesting landowners' day-to-day affect was driven primarily by considerations other than interactions with their forests and other land.

#### *Limitations and future research*

A limitation of this study is we exclusively sampled landowners, not including individuals who did not own any land. Thus, for example, when we find that engagement with one's forested land corresponds with greater positive affect (i.e., happiness), that finding is to be understood relative to *other landowners* who either did not engage with their land at all or who engaged with *other types of nonforest land* (farmland, open land, water, etc.). It is plausible that the magnitude of the measured association between land engagement and affect would be even stronger if the referent group included individuals who owned no land at all. We encourage future research to include samples of nonlandowners to enable more nuanced comparisons (e.g., between forest landowners, nonforest landowners, and nonlandowners) to support further examinations of the role of forest landownership *per se* in subjective well-being. Another similar limitation is that we did not ask if respondents had access to land *other than their own* and thus were unable to control for this factor. Even if respondents did not engage with their own land in the previous 24 or 48 h, they may have visited or recreated on public land or land belonging to friends, family, or neighbors. Similarly, if respondents did not engage with their own forest land, they may have had access to other forest land in this heavily forested region that could have provided them with similar or equivalent benefits. As in the previous case, this likely contributed to a dampening of the association. Therefore, our analysis may be interpreted as a conservative estimate.

A second limitation arises from the fact that weekly surveys were generally sent out on Mondays. Consequently, the previous 24-h and 48-h windows would have included the weekend—when we might expect greater-than-average use of forest land and, potentially, different affect profiles than during the week. It is true that

respondents were asked to return surveys *within 3 days* of receiving them (and some may have returned them even later), meaning that some respondents would have been answering for periods that did not overlap the weekend. That being said, we can likely infer that responses referred to the weekend more often than not. It is our belief that this likely introduced biases in favor of greater land engagement, greater happiness, and reduced negative affect. An improved survey protocol would have randomized the delivery date and included the day of the week as a covariate in the analyses.

Other limitations include a small sample size and low response rate. The former contributes to an analysis with relatively low power to discriminate among the levels of the predictor variables, especially seasonality that did not encompass an entire year. Low response rates can indicate potential response bias. In this case—as in other forest landowner surveys such as the NWOS—the bias is likely in the direction of those landowners who are more engaged and more informed. However, this study was predicated on a random sample of landowners, which means that bias is probably less problematic than in prior studies that recruited from landowner associations (e.g., Huff & Kittredge, 2020). It is known that response rates for mail surveys in the natural resources literature have been declining precipitously over the past few decades, at a rate of almost 1% per year (Stedman, Connelly, Heberlein, Decker, & Allred, 2019). The current study had poor response even by these standards, however. Low and decreasing response rates are associated with general, nonspecific (i.e., nonsalient) topics, email surveys, and overall survey fatigue—some or all of which may have been relevant factors in the current effort. Other surveys, such as the NWOS (Butler et al., 2021), achieve higher response rates through additional mailings, mail-in paper survey instruments, incentives, and an all-around closer implementation of Dillman's (2001) Tailored Design Method. These would likely improve response rates to some extent in future iterations of this work.

Future research could address several of these limitations and shortcomings, as well as explore new research opportunities. One possible future research opportunity relates to ecosystem disservices. Land ownership, differentiated here from land access, confers liabilities as well as benefits on landowners. Landowners must pay property tax on their property, they may have upkeep or maintenance responsibilities, they may face trespassing on their land with associated damage and liability concerns, they may have stresses or concerns related to who is going to inherit their land or have other legal concerns, etc. This supposition is consistent with Fagundes (2017), who argued that property ownership can diminish subjective

well-being due to financial burdens associated with ownership and property maintenance, which result in a reduction of financial freedoms. Although negative affect in the form of “worry” was not significantly related to land engagement in the current study, it is possible that different formulations of worry, anxiety, or related concepts would be, especially if the sample included individuals who owned no land at all. Future research looking at possible negative effects of forest ownership or engagement on well-being would be fruitful. Property taxes, trespassing, vandalism, and keeping their forest land intact are significant concerns for many family forest landowners (Shanafelt, Danley, Caputo, & Brunette, 2025), so research that asked landowners to think about these topics in relation to the well-being benefits that ownership or engagement confer might yield more nuanced results about negative affect. Ecosystem disservices or negative well-being effects may influence how landowners steward their land or whether they plan to sell it or pass it on to family members or other heirs. Furthermore, recognizing the fact that forest land may bring liabilities as well as benefits may allow foresters, conservationists, policy makers, and other service providers to more successfully engage with landowners to promote mutually beneficial outcomes (e.g., Caputo et al., 2026a).

One area where future research could meaningfully expand upon the current research is in terms of longitudinal research. In the current study, neither date nor seasonality was a significant predictor of landowner well-being. The current study was a short-term project, however, conducted over a 6-month window. A research time frame covering multiple years would allow for robustly testing the relations between seasonality, land engagement, and landowner well-being across a meaningful stretch of time relative to the scale of ownership tenure. This approach could be incorporated within a long-term cohort study of forest landowners. This would enable exploring the impact of rare and periodic events on measured well-being. These rare events would include timber harvests, large-scale forest disturbances, and land transfers—events that happen only occasionally in landowners' tenure but which have potential for significant, disruptive influence on landowner well-being. For example, Gobster et al. (2022) examined how forest owners experienced disturbance—a *derecho*—and its aftermath, finding owners had deep feelings of loss associated with the changes in their land. The current study, because of its short time frame, required a focus on frequent, repetitive events with a reasonable likelihood of occurring on a week-to-week basis—events such as visiting land, recreating, and thinking about forest land. These are the most common sorts of interactions that landowners have with their land and are

therefore very important, but they are not likely to be the events and interactions with the biggest individual impacts on landowner well-being. A long-term cohort study offers the best scope for researching those impacts. In addition, a longitudinal study would allow for an exploration of whether there are points in one's ownership tenure, perhaps closely linked to landowner age, where land engagement and ownership affect well-being differently. For instance, advancing landowner age or health concerns or unexpected financial needs may impart more negative well-being effects than at other points of one's ownership tenure. These are also the points where landowners are likely to be making important decisions regarding their land—whether to sell land or liquidate timber value, etc.—that will impact themselves, their family, the forest, and society at large. Other life events—marriage or divorce, children, loss of parents, changes in income, etc.—are likely to have even larger impacts on landowner well-being than anything directly related to their land. Long-term research that collects data on these events and analyzes their effects, independently as well as in interaction with land-related events, is likely to produce a fuller picture of what drives the well-being of forest and other landowners. Qualitative or mixed-mode research is likely to be particularly satisfactory as a way of exploring the nuanced and highly contextualized ways in which forest and land ownership contribute to human well-being (e.g., Bliss & Martin, 1989; Caputo, Robillard, Snyder, & Markowski-Lindsay, 2026b).

## Conclusions

Landowners in the Great Northwoods region of the USA report high levels of life satisfaction and eudaimonic well-being. These evaluative measures, however, were not found to be significantly related to whether or not landowners owned forestland or how often they visited their land or what they did there. In contrast, recent forest and land engagement (visiting, recreating on, or thinking about land) did significantly predict higher positive affect (i.e., “happiness”). We can therefore conclude that engaging with one's forested land can significantly (although modestly) make landowners happier in the short-term, even if it does not impact landowners' retrospective evaluation of their long-term life satisfaction and sense of having a worthwhile life. Forestry professionals often seek new ways to support and connect with private owners. Understanding the link between land engagement and well-being may open new ways to reach forest landowners for increased conservation, stewardship, cross-boundary and cross-ownership coordination, and management behavioral support, all in service of keeping

forests as forests on private lands. This information may be particularly useful to support new and beginning landowners who are facing land use decisions that could involve developing their land into nonforest uses.

The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

## Acknowledgments

The authors thank Andrea Jerlecki, Katherine Nocks, Brynna Wesley, and Corinthian Martorana for assistance with data entry, cleaning, and management. Finally, they thank John Brown, Chris Mihlar, and Michelle Kondo for carefully reviewing an early version of the article; their thoughtful suggestions were valuable. We appreciate and acknowledge acquisition of property and parcel data through the ReGRID “Data with a Purpose” program.

## Authors' Contributions

J.C.: Conceptualization, data collection, investigation, data curation, formal analysis, software, writing—original draft, and writing—review and editing. E.S.: Conceptualization, funding acquisition, supervision, project administration, resources, data collection, investigation, and writing—review and editing. S.G., S.A.S., and K.F.: Writing—review and editing. A.C.: Data collection, supervision, and writing—review and editing.

## Ethical Considerations

The survey instruments and study plans were reviewed and approved by the Institutional Review Board (IRB) at Michigan State University (STUDY00006383).

## Consent to Participate

Respondents were given written permission to opt out of the survey at any time, permission which was reiterated in the introduction to each survey instrument they received (see Supplementary Data S1).

## Availability of Data and Material

Raw data are available from authors upon request.

## Author Disclosure Statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding Information

Funding was provided by Michigan State University through Dr. Emily Silver's research lab. This work was also partially funded by the U.S. Forest Service.

## Supplementary Material

Supplementary Data S1

Supplementary Data S2

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Received: February 17, 2026

Accepted: July 29, 2026