



## RESEARCH ARTICLE



# The meaning(s) of place: Identifying the structure of sense of place across a social–ecological landscape

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**Abstract**

1. Sense of place holds promise to understand how people perceive and respond to social and ecological change; however, using this concept to explore vulnerability and adaptation first depends on identifying the multiple ways people define their relationship with a place.
2. We introduce the meaning-dependence framework to account for the broad array of person–place connections within social–ecological landscapes.
3. We applied this framework to private landowners in the Southern Great Plains of the United States, a working landscape experiencing ecological transformation from grasslands to degraded woodlands.
4. Using a mail survey, we explored the structure of sense of place based on the relationship between place meanings and place attachment. We employed complementary analytical methods: correlation analysis, ordinary least squares regression, and machine learning through a regression tree and random forest.
5. Place meanings explained a large amount of variation in place attachment and were characterized by intercorrelations and interactions. Across analyses, experiential meanings reflecting personal psychological connections to one's land were the predominant drivers of landowners' place attachment. *Way of life* emerged as a central meaning for understanding sense of place on private lands.
6. The meaning-dependence framework builds on existing research to account for the multiple ways meanings inform human connections to a place. This framework is broadly applicable to any setting and can capture diverse configurations of person–place relationships and increase the utility of sense of place in social–ecological research.

**KEYWORDS**

machine learning, place attachment, place meanings, private lands, relational values, sense of place, social–ecological systems, way of life

## 1 | INTRODUCTION

The vulnerability of social–ecological systems to drivers of change is inherently place-based, and there is increasing recognition of

sense of place as an important tool to understand responses and develop solutions (Adger, 2006; Cheng, Kruger, & Daniels, 2003; Kofinas, 2009; Masterson, Stedman, et al., 2017; Stedman, 2016). Sense of place describes the wide range of connections between

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people and places that develops based on the place meanings and attachment a person has for a particular setting (Lewicka, 2011; Relph, 1976; Trentelman, 2009; Tuan, 1977). An individual's sense of place can be a vital component of their well-being and is recognized as an important, life-enriching ecosystem service (Chan et al., 2016; Ryfield, Cabana, Brannigan, & Crowe, 2019).

The meanings and attachment that underpin sense of place may guide preferences for and shape responses to social and ecological change (Davenport & Anderson, 2005; Masterson, Stedman, et al., 2017). Collectively, a shared sense of place may enhance human capacity to adapt and respond to change by motivating conservation and pro-environmental behaviours that promote long-term stewardship and transitions towards sustainability (Chapin III, Mark, Mitchell, & Dickinson, 2012; Masterson, Stedman, et al., 2017; Walker & Ryan, 2008). However, sense of place often varies among people in the same locale; even seemingly similar types of resource users may not share the same sense of place (Gurney et al., 2017; Yung, Freimund, & Belsky, 2003). As people value certain aspects or characteristics of places differently, they may in turn perceive different risks and experience unequal vulnerability to place change (Devine-Wright & Howes, 2010; Quinn, Bousquet, & Guerbois, 2019; Smith, Anderson, & Moore, 2012). Different construals of sense of place can be the root of conflicts over natural resource use and the desired future of a place impeding collaborative management efforts in response to social and ecological change (Chapin III & Knapp, 2015; Devine-Wright, 2009; Yung et al., 2003).

Sense of place is a promising but underutilized concept in social-ecological research (Masterson, Stedman, et al., 2017). Despite rich theory, an active discourse continues about its application to social-ecological settings given the diversity of conceptual and methodological approaches that exist (for detailed discussion see Eaton et al., 2019; Lyon, 2014; Masterson, Stedman, et al., 2017; Stedman, 2003; Trentelman, 2009). Four major research needs have been identified to improve understanding of sense of place and its capacity in social-ecological research. First, although qualitative approaches are often used to study sense of place (e.g. Gustafson, 2001; Manzo, 2005), quantitative methods that can assess place constructs across larger samples and geographic areas are needed (e.g. Wynveen & Kyle, 2015) to identify patterns and systematic variations in sense of place to help explain place-related behaviour (Masterson, Stedman, et al., 2017; Stedman, 2003). Second, while research has often focused on the common sense of place shared by a group of people, there is an increasing need to identify differences in sense of place which can provide valuable insights into roots of conflict, barriers to collaboration, and varied behavioural responses to social-ecological change (e.g. Davenport & Anderson, 2005; Devine-Wright & Howes, 2010; Masterson, Stedman, et al., 2017; Quinn et al., 2019; Yung et al., 2003). Third, much sense of place research has focused on transient users, like second homeowners or tourists, in areas with high natural amenities (e.g. Jaakson, 1986; Williams & Vaske, 2003; Wynveen, Kyle, & Sutton, 2012). The concept needs improvement for application to places that are not as 'easy to love' such as the mixed-amenity areas common to working landscapes (Eaton et al., 2019; Trentelman, 2011).

Finally, there is a significant disconnect between the conceptualization and measurement of sense of place on privately owned working lands where person-place dynamics may be unique from transient users of natural areas (Eaton et al., 2019).

In recognition of these research needs, we use private lands as an exemplar to reconsider how sense of place is conceptualized and operationalized. Land under private ownership (e.g. individuals and families) constitutes more than 60% of the United States (Bigelow & Borchers, 2017) and is critical to many landscape-scale management efforts (Bennett, Pejchar, Romero, Knight, & Berger, 2018). Private lands are imbedded within larger social-ecological systems and are of increasing global conservation importance (Capano, Toivonen, Soutullo, & Di Minin, 2019). Understanding sense of place on private lands is important because landowners are key arbiters of and responders to social-ecological change. Their sense of place can catalyze stewardship and conservation behaviours but may also inhibit adaptation and transformation (Eaton et al., 2019; Masterson, Stedman, et al., 2017).

We focus on the sense of place of private landowners in the Southern Great Plains of the United States. This region is a mixed-amenity working landscape where ecological transformation of grasslands to degraded woodlands has progressed in recent decades largely due to reduced fire and over grazing (Briggs et al., 2005; Wilcox et al., 2018). Concerns exist about how this region can effectively adapt to maintain its grassland state and sustain its rural population. Adaptation is the purview of the private landowner as over 90% of land in this region is privately owned (Assal, Melcher, & Carr, 2015). Understanding landowners' sense of place is a critical first step for social-ecological research examining human perceptions and responses to grassland transformation in this region.

Integrating concepts from the sense of place literature with private landowner and working lands research (e.g. resource dependency), we propose an alternative conceptualization of and measurement approach to sense of place that addresses the need to enhance its applicability to social-ecological research. We introduce the meaning-dependence framework, which combines the degree to which a place meaning represents a landowner's beliefs with the degree to which a landowner is dependent on their land as a source of the meaning. We apply our framework to private landowners in the Southern Great Plains and explore the structure of sense of place based on the relationship between place meanings and place attachment. From this, we illustrate a fairly complex structure characterized by multiple configurations of place meanings that lead to varying levels of attachment. On both private and public lands, improved ability to measure and represent sense of place adds depth to our understanding of the phenomenon itself and can enhance the utility of sense of place as a tool to understand responses to social-ecological change.

## 2 | THE MEANING-DEPENDENCE FRAMEWORK

A comprehensive understanding of sense of place must begin with the consideration of a wide range of place meanings. The meanings

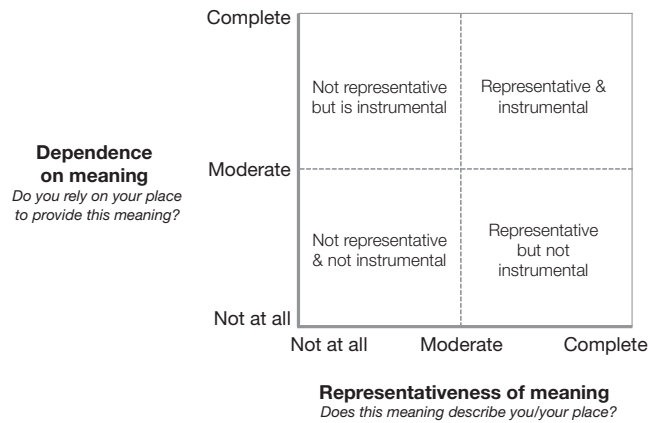
landowners hold for their property range from simple descriptions (e.g. my place is a farm) to highly symbolic sentiments (e.g. my place is where I feel most at home). These beliefs about their property convey its character and symbolic value to the landowner (Stedman, Amsden, Beckley, & Tidball, 2014). The way people relate to their land has never been truly homogenous (Robbins, Meehan, Gosnell, & Gilbertz, 2009), and the demographic transitions on rural lands towards amenity-based land ownership in the United States, Australia, and Europe (Brown, Johnson, Loveland, & Theobald, 2005; Luck, Black, & Race, 2011; Moss, 2006) necessitate an approach that allows for a large suite of place meaning indicators. For instance, private landowners in working landscapes may relate to their land as a residence, a place of work, a haven, a recreation or vacation spot, and so on. For some landowners, their land holds meaning as a crucial part of their livelihood, heritage, and identity. For others, the land represents a rural retreat to find psychological restoration and an escape from daily life. To navigate the transitions occurring on private lands, it is important to understand the wide range of meanings that connect landowners to their land because of the myriad ways that places matter (Chan et al., 2016; Tadaki, Sinner, & Chan, 2017).

Although the expression of place meanings may be inherently unique to a specific place, many types of place meanings have been identified across research contexts. Multiple typologies of place meanings exist and generally include: (a) place characteristics focused on attributes of the biophysical setting, (b) functional or utilitarian meanings related to actual or desired uses, (c) experiential meanings formed through individually oriented experiences, and (d) interpersonal meanings based on interactions with others and the social aspects of place (Davenport & Anderson, 2005; Gustafson, 2001; Masterson, Stedman, et al., 2017; Stedman, 2002; van Riper, Kyle, Sutton, Tobin, & Stronza, 2012; Williams & Vaske, 2003; Wynveen & Kyle, 2015; Wynveen et al., 2012).

While place meanings represent the cognitive mechanism by which sense of place forms, many landowners also have instrumental connections to the land that can be understood in terms of dependence. People depend on places for myriad reasons ranging from aspects of livelihood to psychologically restorative experiences like enjoyment, solitude, and freedom (Davenport & Anderson, 2005). For private landowners utilizing the natural resources on their land, place dependence is conceptually similar to resource dependency—the dependence that forms through deriving one's livelihood from resource-based activities (Marshall & Marshall, 2007). The resource dependency framework examines the degree to which agricultural producers rely on a natural resource to sustain their livelihoods not only as a source of income, but also because their livelihood may be embedded in social, cultural and cognitive environmental dimensions of their life (e.g. Marshall, 2011; Marshall et al., 2016; Marshall, Stokes, Webb, Marshall, & Lankester, 2014). Similarly, place dependence represents an instrumental view that focuses on the ability of a setting to facilitate opportunities for goal or activity achievement regardless of whether a landowner's goal is income, enjoyment, or some combination (Davenport & Anderson, 2005; Masterson, Stedman, et al., 2017).

Integrating place dependence and resource dependency requires reconsidering how place dependence is conceptualized and measured. Typically, quantitative measures of place dependence are holistically framed around the degree to which a place is the single *best* place for a particular activity (e.g. Jorgensen & Stedman, 2001; Williams & Vaske, 2003). While this may be appropriate for groups with similar functional goals for a place, such as recreational homeowners in natural amenity areas (Jorgensen & Stedman, 2001) or visitors to outdoor recreation areas (Williams & Vaske, 2003), it fails to account for the heterogeneity in how landowners rely on their land (Eaton et al., 2019; Mihaylov & Perkins, 2014). In the world of private lands, many landowners do not live on the best place to achieve their land management goals, yet this may have little effect on their dependence on the land. Within sense of place scholarship, there have been a range of efforts to expand the applicability of place dependence. Gurney et al. (2017) adapted the construct to include direct dependence for activity-based goals and indirect dependence related to overall well-being. Eaton et al. (2019) suggest that different dimensions of dependence, such as economic and livelihood/lifestyle dependence, may be especially important in working lands contexts. Others have reconceptualized broad measures of place dependence as a type of place meaning related to self-efficacy or the facilitation of a desired activity (e.g. Smith, Davenport, Anderson, & Leahy, 2011; Wynveen & Kyle, 2015). Smith et al. (2012) contend that individuals are inherently dependent on a place for the behavioural or social-psychological place meanings that they attribute to it. Given this interpretation, however, consider a wealthy landowner who uses their land as a second home with a small cattle operation leased out to their neighbour. This landowner may characterize their land as a source of income (functional meaning), yet indicate that they do not depend on this income. Instead, they may rely more strongly on their land as a place to escape and gain perspective on their life (experiential meanings). Although landowners hold many meanings for their land, they may only depend on their land to realize a subset of those meanings.

The recognition that landowners hold multiple place meanings, with varying levels of dependence on each meaning, has implications for the measurement of place dependence. While the resource dependency framework considers various dimensions of dependence (e.g. economic, livelihood and social), it focuses specifically on agricultural producers with productivist values and economic dependence. As such, it is not general enough to include the ways a growing number of non-production-oriented landowners in rural working landscapes relate to and depend on their land. A landowner need not be a producer to be dependent on their land for the specific place meanings they hold as their land may also facilitate social and psychological aspects of their life such as their identity, social networks, or membership and involvement in the community. Consequently, to more comprehensively understand private landowners' sense of place, it is necessary to not only measure how representative a place meaning is to them, but also to account for the degree to which they depend on the meaning (Figure 1).



**FIGURE 1** Measuring place meanings for private lands includes understanding how well it represents a landowner's beliefs about their place (x-axis) and the degree to which they rely on their place to provide the meaning (y-axis)

The configurations of place meanings that represent landowners' beliefs about their land along with their reliance on it to supply such meanings comprise the nature of their connection with the land. The more salient place meanings are to one's sense of self or role in social life, the more central they may be to a landowner's self-definition producing feelings of attachment to the setting (Stedman, 2002). Place attachment serves as the evaluative component of sense of place indicating the intensity and valence of one's connection to the land based on the specific place meanings held (Low & Altman, 1992; Manzo, 2005; Stedman, 2002). For example, a landowner may be attached to the land because it provides a welcome escape from urban living without necessarily relying on their land to do so. Their attachment may be strengthened through an instrumental connection if they view their land as an escape *and* they rely on their land to supply this escape.

Although place attachment is widely considered an outcome of an individual's place meanings (e.g. Low & Altman, 1992), indicators that comprise place attachment are place meanings themselves. Thus, the two-dimensional construal of representativeness and dependence can also be applied to the measurement of place attachment. While some variation exists, place attachment is commonly conceptualized as an affective connection and the integration of the social and physical setting with one's self-identity (e.g. Stedman, 2002). Identity is considered a relational value that can connect people to their land (Klain, Olmsted, Chan, & Satterfield, 2017). Similar to sense of place, the source of a person's self-identity lies in the meanings that inform their sense of self (Burke & Stets, 2009; Tadaki et al., 2017). Grounded in the concept of self-identity, place identity is fundamentally comprised of place meanings when the setting helps an individual: (a) distinguish their personal uniqueness from others (distinctiveness), (b) define their self-worth or social value (self-esteem), (c) maintain or change their sense of self (continuity), and (d) demonstrate their personal agency (self-efficacy; Manzo & Perkins, 2006; Proshansky, 1978; Twigger-Ross & Uzzell, 1996). As with other place meanings, a landowner

may characterize their land as a source of pride (the self-esteem meaning represents their beliefs), but not rely on their land as a principal source of their sense of self-worth (low dependence on self-esteem meaning). Measuring place attachment as a set of place meanings using the meaning-dependence framework increases the compatibility between place meanings and place attachment measures, thereby enhancing explanatory power of meanings by reducing measurement error (Fishbein & Ajzen, 2010).

In summary, the meaning-dependence framework modifies sense of place and its measurement in an effort to broaden its relevance to a wider range of people and places. Both place attachment and place meanings are critical for understanding sense of place and subsequent place-related behaviour (Brehm, Eisenhauer, & Stedman, 2013; Masterson, Stedman, et al., 2017; Stedman, 2003). Measuring how a person's place meanings and their associated dependence on such meanings relate to their place attachment captures both the nature and strength of their sense of place. Examining a comprehensive list of possible meanings that range from those typically associated with producers to those typically associated with recreationists provides greater breadth and depth in the investigation of people's sense of place.

### 3 | METHODS

Similar to many studies examining place meanings, we use place attachment as the outcome of meanings (e.g. Stedman, 2002; Stedman et al., 2014; Wynveen et al., 2012). Yet, little is known about the multiple configurations of such meanings that generate varying degrees of place attachment among private landowners in working landscapes. A number of studies have investigated person-place relationships using meanings, and all are exploratory in the sense that they seek to identify the meanings relevant to a specific population within a particular context (e.g. Davenport & Anderson, 2005; Masterson, Tengö, & Spierenburg, 2017; Smith et al., 2011; Van Patten & Williams, 2008). We adopted this exploratory approach in a survey to private landowners in the Southern Great Plains of the United States. We employed a suite of statistical and machine learning approaches to successively investigate how place meanings relate to place attachment: correlation analysis, ordinary least squares (OLS) regression, a regression tree, and a random forest. Each analysis provides a unique lens to explore person-place relationships and understand the structure of sense of place. This is a crucial component of a larger research endeavour to understand how sense of place relates to adaptation to changing social-ecological conditions.

#### 3.1 | Study area

The Southern Great Plains of the United States experienced Euro-American colonization and settlement in the 1800s as agriculturalists acquired land for grazing and cultivation (Assal et al.,

2015). Similar to other rural areas of the United States, recent demographic changes and land use trends suggest that the land ownership matrix in the Southern Great Plains has shifted from a predominately agricultural orientation to encompass landowners with broader land use preferences and ownership motivations that include rural and natural amenities along with, or perhaps over, the land's production potential (Berg et al., 2015; Brown et al., 2005; Sorice, Kreuter, Wilcox, & Fox III, 2012, 2014). Property size in rural rangelands throughout the Southern Great Plains has become increasingly bimodal; there has been an increase in both the number of very large properties through consolidation and in the number of smaller properties through increased subdivision of land (Wilcox et al., 2018). Still, the Southern Great Plains remains a working landscape perhaps best characterized as a mixed-amenity region lacking the 'high grandeur' of resorts and national parks in the more amenity-rich areas of the United States (Trentelman, 2011).

This study focused on 53 counties across three ecoregions: 11 counties in the Flint Hills in eastern Kansas, 32 counties in the Central Great Plains in central and western Oklahoma, and 10 counties in the Edwards Plateau in west central Texas (Omernik, 1987; Omernik & Griffith, 2014; see Supporting Information for study area map). The Southern Great Plains is undergoing dramatic ecological change through the expansion of woody trees and shrubs into grasslands. As a whole, this area has the highest rate of grassland conversion to woodlands within the United States. Woody plant expansion varies greatly across the three ecoregions, with conversion most extensive in the Edwards Plateau, intermediate in the Central Great Plains, and minimal within the Flint Hills (Wilcox et al., 2018). This ecological transformation is intimately tied to the management decisions of landowners because the study area is over 90% privately owned and sense of place may guide how landowners adapt to such change (Assal et al., 2015; Masterson, Stedman, et al., 2017). Current landowners in the study region are largely Euro-American decedents; therefore, we recognize that indigenous understandings of place and connections to the landscape are not accounted for by our research.

### 3.2 | Survey design

To reach a large sample of geographically distributed landowners, we employed a self-administered mail survey, which has been successful in previous research with subgroups of this population (Sorice et al., 2012; Toledo, Sorice, & Kreuter, 2013). The full survey instrument requested information about land use and landowner characteristics; sense of place; exposure to, preferences for, and beliefs about cedar/juniper; land management practices used to control cedar/juniper; and basic demographics (see Rajala, 2018; Appendix B). Because landowners in the region colloquially refer to their overall landholdings as their *place*, we based sense of place questions around the prompt 'My place is...'. However, to maintain clarity in this manuscript we will also refer to their place as their land or their property.

### 3.3 | Measuring place meanings & place attachment

Place meanings require considerable development to ensure that the measurement items are salient to the population being studied (Wynveen & Kyle, 2015). We began by conducting an extensive review of sense of place and general private landowner literature and investigated the theoretical underpinnings of place meanings identified in previous qualitative and quantitative research to create a catalogue of place meanings.

We expanded and modified our initial catalogue of meanings through field work in the study region between July and September 2017. Field work involved meetings with rangeland practitioners, attending landowner workshops, participant observation, landowner-led property tours, and iterative qualitative interviews ( $n = 34$ ) with a diverse array of landowners. We then refined the place meaning items for clarity through pretesting and cognitive interviewing with landowners and specialists throughout the study's three ecoregions. Through this work we found that many of the experiential and interpersonal meanings were higher order concepts that consisted of multiple indicators. For instance, we used five place meaning items to measure distinct aspects of psychological restoration (i.e. clearing one's mind, eliminating distractions, escape, stress reduction, and reflection). Ultimately, we developed 46 place meaning indicators that represented place characteristic meanings, functional meanings, experiential meanings, and interpersonal meanings with wording customized to private landowners in the Southern Great Plains (see Supporting Information for place meaning survey items and additional literature cited).

Because place attachment is composed of experiential meanings related to affect and the integration of place with one's sense of self (e.g. Stedman, 2002; Wynveen & Kyle, 2015), eight of our 46 place meaning items were indicators of place attachment. These included the affective items *feeling at home*, *missing it when away*, and *feeling happiest there*. Integration of place with self drew from the following dimensions of self-identity commonly used to measure place attachment: distinctiveness (*reflects who I am*), self-esteem (*personal pride*), continuity (*shaped who I've become*), and self-efficacy (*live life how I want*; Twigger-Ross & Uzzell, 1996). We included the self-expression item *somewhere I can really be myself* in our index based on the prior success of this indicator in previous place attachment scales (e.g. Stedman, 2002). To maintain clarity, we will refer to the place meaning items that comprise our dependent variable as *place attachment* to distinguish it from other place meanings that serve as independent variables.

For each of the 46 place meaning and attachment items, respondents indicated the degree to which the item represented their beliefs and then indicated their dependence on their land to supply the meaning. We measured both using 5-point Likert-type scales from 0 = *Not at all* to 4 = *Completely*. Where appropriate for the dependence measure, we asked landowners to consider the degree to which they rely on their land to supply each meaning relative to 'any other place'.



### 3.4 | Sampling and survey administration

To obtain broad coverage, we randomly sampled 1,000 landowners in each ecoregion using public property records from each county in the study area. We employed a probability proportionate to size sampling scheme based on the number of eligible landowners in each ecoregion to protect against over and under sampling counties that vary in the number of eligible landowners (see Rajala, 2018; Appendix A). We sampled landowners with at least 30 acres of land to ensure that the land ownership and management questions would be salient while capturing differences in place meanings held by large and small acreage landowners. After filtering out invalid addresses, our final sample size was 2,993 landowners across the 53 counties in the three ecoregions of the study. We distributed the survey following a slightly modified tailored design approach (Dillman, Smyth, & Christian, 2014) comprised of five mailings over the course of 9 weeks between February and May 2018. Ethical approval to conduct this research was approved by the Virginia Tech Institutional Review Board (IRB # 17-1124) and informed consent from participants was implied by the return of completed questionnaires.

### 3.5 | Data analysis

For each place meaning and attachment item, we added the representativeness component to the dependence component to represent the overall strength of the meaning/attachment item to the landowner. This additive approach accounts for the conceptual premise that place attachment can form based on either representativeness or dependence, or as a combination of the two. The resulting scale ranged from 0 to 8, where 8 indicates that the meaning completely represents the landowner's beliefs and they completely depend on their land to provide the meaning. Similar to other sense of place research, we created a single index for place attachment from our eight experiential place meaning items (Cronbach's  $\alpha = 0.92$ ; e.g. Lewicka, 2011; Quinn et al., 2019; Stedman, 2002).

We employed four complementary analyses to explore the structure of sense of place. First, we used Pearson correlations to identify the strength, significance, and nature of individual relationships between place attachment and each place meaning, while ignoring the effects of other meanings. Second, we conducted OLS regression to examine the ability of meanings to jointly explain place attachment. In addition to the regression coefficients and statistical significance, we examined the partial omega-square effect sizes, which estimate a meaning's effect on place attachment while removing the effects of other independent variables. We also looked at the variance inflation factors (VIFs) for each place meaning to identify potentially problematic collinearity amongst meanings. We considered individual VIFs  $>2.5$  and an average VIF  $>1.0$  as a cause for concern about multicollinearity (Acock, 2016; Bowerman & O'Connell, 1990). Finally, we examined structure coefficients, which are bivariate correlations between meanings and the predicted place attachment. Many of the meanings used to explain attachment are intercorrelated, and

structure coefficients provide additional information as to which variables substantively contribute to place attachment but were denied credit (i.e. statistical significance) because of the common variance they share with other meanings (Sorice, 2012).

Because our goal was to understand the structure of sense of place, we did not remove collinear variables. Instead, we further explored the relationship between place meanings and place attachment using machine learning decision tree techniques, which are nonparametric alternatives to OLS regression that shift focus from statistical significance to a goal of predictive accuracy using bootstrapping and cross-validation methods (Hastie, Tibshirani, & Friedman, 2017). Such approaches are able to explore nonlinearities and interactions that can be difficult to identify a priori or cumbersome to incorporate into regression models. Although predominantly discussed in terms of prediction, decision trees can be readily applied to cases where the goal is explanation but theoretical guidance is lacking. In this case, the theory is clear that meanings should explain place attachment but unclear on whether meanings are linearly related to place attachment, whether they interact with each other, or which meanings should best explain place attachment.

Third, we conducted a regression tree analysis that iteratively partitions landowners into groups that optimize the reduction of within-group variability and maximize between-group differences. At each iteration, all meanings are examined and a single meaning is selected that provides the largest reduction in the sum of squares when following a specific splitting rule. Each split increases similarity in the place attachment of the respondents in resulting groups. We employed two stopping rules to generate an optimal regression tree that statistically balances parsimony with goodness of fit. We used the Partition Tree algorithm in JMP Pro 14.0.0 with  $k$ -fold cross-validation ( $k = 5$ ) to test the model at each stage. This approach terminates the model when the improvement in the  $R^2$  value is at its minimum—none of the subsequent 10 models have a cross validation  $R^2$  showing an improvement  $>0.005$  units (SAS Institute Inc, 2018). We also employed a minimum group size of 10 landowners. Because the goal of the regression tree is to create disparate groups, it obviates the need for further statistical comparisons of place meanings (e.g. ANOVA), which would be cumbersome across numerous groups. To explore additional variation in landowner groups, we created a visualization that uses locally weighted regression and smoothing lines over scatterplots of the relationship between the average place attachment for each group and common landowner and land use characteristics (Cleveland, 1979). These smoothing line visualizations and information about additional variable measurement can be found in the Supporting Information.

While regression trees are highly suitable for data exploration and description of a specific sample, they tend to not be reproducible with future data because changes in data can lead to changes in the structure of a single tree. Thus, we concluded our analysis with a random forest, which improves the robustness of the single regression tree by using bootstrapping to randomly sample a subset of indicators and observations and generate an ensemble of regression trees, all of which vary in their predictive accuracy (Hastie et al., 2017). The resulting ensemble can be used to collectively rank

the importance of meanings in explaining place attachment and identify which variables would be most important in predicting the same outcome in additional samples or populations. We generated a random forest to explain place attachment based on place meanings using the Bootstrap Forest algorithm in JMP Pro 14.0.0. We used the default model parameters specifying that the forest have 100 trees, a minimum of 10 splits per tree, sample nine variables per split, and have a minimum size of five observations (i.e. landowners) per candidate split. Rather than focus on prediction, we used this approach to identify each place meaning's contribution to explaining place attachment as indicated by the proportion of sum of squares explained.

## 4 | RESULTS

Of the 2,993 initial surveys distributed, our response rate adjusting for ineligible respondents (e.g. undeliverable addresses, etc.) was 35%. We restricted the sample to respondents who indicated they were responsible for making most of the day-to-day decisions about their land ( $n = 877$ ). Due to item non-response in the place meanings and attachment questions, this analysis is based on 535 respondents.

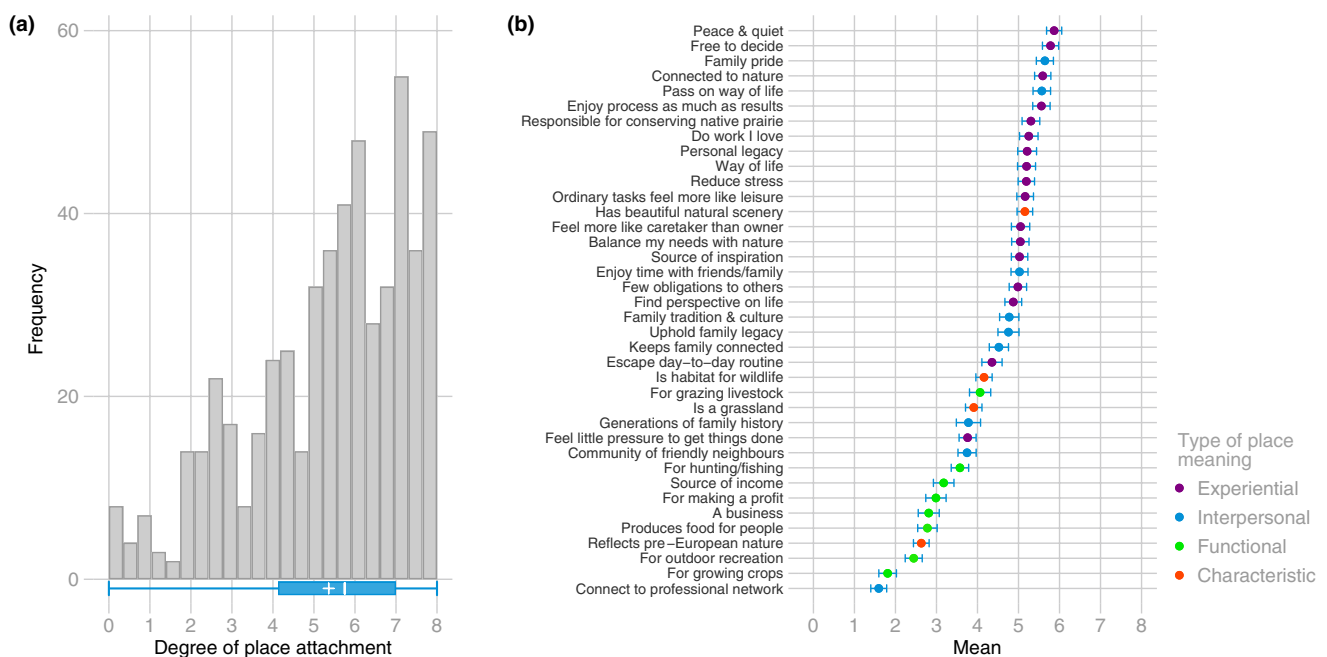
Overall, landowners' levels of place attachment were moderate to slightly high ( $M = 5.4$ ;  $SD = 1.9$ ; median = 5.8) with 50% of landowners falling between 4 (moderate) and 7 (high) on a scale of 0–8 where 8 indicates maximum place attachment (Figure 2a). Experiential and interpersonal meanings were rated the highest by landowners while functional and characteristic place meanings were rated the lowest (Figure 2b). On average, *peace and quiet*, *freedom to decide*, and *family pride* were the highest rated (range:  $M = 5.64$ – $5.87$ ) while beliefs that one's place was

for outdoor recreation, for growing crops, and connecting to one's professional network were rated the lowest (range:  $M = 1.59$ – $2.44$ ).

### 4.1 | Correlation analysis

Examining the Pearson correlation coefficients, all variables were significantly and positively related to place attachment with the exception of *habitat for wildlife*, *for hunting and/or fishing*, and *for other outdoor recreation* (Table 1). The average correlation between meanings and place attachment was 0.45 (median = 0.49) indicating that most meanings correspond fairly strongly with place attachment. The top six meanings most strongly related to place attachment ( $r > 0.70$ ) were all experiential, personal psychological meanings for place (Table 1). Foremost, was the characterization of their place as a way of life followed by *free to decide*, *perspective on life*, *doing work that one loves*, *peace and quiet*, and *source of inspiration*.

While not as strongly correlated as experiential meanings, interpersonal meanings highlighting the core motivation of belongingness were also positively related to attachment (range:  $r = 0.47$ – $0.55$ ). Family heritage items of *keeping family connected*, *representing traditions and culture*, and *upholding family legacy* were correlated with place attachment as was the importance of one's place for *enjoying time with friends and family* and as *part of a community of friendly neighbours*. *Professional connections* was also related but to a somewhat lesser degree than other interpersonal meanings ( $r = 0.39$ ). The characteristic and functional meanings of place tended to have the lowest significant correlations with place attachment (e.g. *my place is a grassland*,  $r = 0.26$ ; *my place is for growing crops*,  $r = 0.12$ ). The full correlation matrix is in the Supporting Information.



**FIGURE 2** (a) Histogram and boxplot displaying distribution of place attachment. The plus sign (+) represents the mean while the vertical bar represents the median. (b) Means and confidence intervals for meanings assessed in this study. Colours indicate the type of place meaning

**TABLE 1** The relationship between place meanings and place attachment. The first four columns show the unstandardized coefficients (*b*), partial omega-squared, variance inflation factors, and structure coefficients for an ordinary least squares regression of place attachment on place meanings. The last column provides the Pearson correlation (*r*) between each meaning and place attachment

Variable	Regression output				Correlation
	<i>b</i>	Partial omega-squared	Variance inflation factor	Structure coefficient	<i>r</i>
Constant	0.089	–	–	–	–
Characteristic meanings					
Is a grassland	0.022	<0.001	2.23	0.274	<b>0.255*</b>
Has beautiful natural scenery	0.021	<0.001	1.89	0.266	<b>0.248*</b>
Reflects pre-European nature	–0.002	–0.002	1.43	0.155	<b>0.145*</b>
Is habitat for wildlife	0.006	–0.002	2.85	0.063	0.059
Functional meanings					
For grazing livestock	<b>0.045*</b>	0.014	2.37	0.280	<b>0.261*</b>
For growing crops	0.013	–0.001	1.93	0.127	<b>0.119*</b>
Produces food for people	–0.017	<0.001	1.92	0.216	<b>0.201*</b>
For hunting/fishing	<b>–0.039*</b>	0.007	2.09	0.021	0.020
For outdoor recreation	0.014	–0.001	2.10	0.079	0.074 <sup>#</sup>
For making a profit	–0.022	–0.001	6.91	0.245	<b>0.229*</b>
Source of income	0.036	0.001	7.18	0.247	<b>0.230*</b>
A business	0.026	0.001	3.65	0.282	<b>0.263*</b>
Experiential meanings					
Free to decide	<b>0.173*</b>	0.093	3.07	0.822	<b>0.767*</b>
Few obligations to others	0.001	–0.002	2.39	0.546	<b>0.509*</b>
Personal legacy	<b>0.086*</b>	0.028	3.42	0.717	<b>0.668*</b>
Reduce stress	<b>0.107*</b>	0.023	4.97	0.732	<b>0.682*</b>
Peace and quiet	<b>0.093*</b>	0.013	5.23	0.765	<b>0.713*</b>
Feel little pressure to get things done	–0.004	–0.002	2.06	0.386	<b>0.359*</b>
Find perspective on life	<b>0.067*</b>	0.009	4.47	0.805	<b>0.750*</b>
Source of inspiration	0.037	0.003	3.38	0.764	<b>0.712*</b>
Escape day-to-day routine	–0.025	0.002	2.42	0.431	<b>0.401*</b>
Ordinary tasks feel like leisure	–0.046 <sup>#</sup>	0.006	3.20	0.697	<b>0.650*</b>
Enjoy process as much as results	<b>0.043*</b>	0.006	2.97	0.751	<b>0.700*</b>
Do the work I love	<b>0.060*</b>	0.010	4.20	0.794	<b>0.740*</b>
Way of life	<b>0.178*</b>	0.114	3.25	0.853	<b>0.795*</b>
Connected to nature	0.030	0.001	3.41	0.723	<b>0.674*</b>
Responsible for conserving native prairie	–0.013	–0.001	2.59	0.501	<b>0.467*</b>
Balance my needs with needs of nature	0.006	–0.002	3.00	0.569	<b>0.530*</b>
Feel more like caretaker than owner	0.023	0.002	1.91	0.568	<b>0.529*</b>
Interpersonal meanings					
Family traditions and culture	–0.044 <sup>#</sup>	0.005	3.98	0.486	<b>0.453*</b>
Family pride	<b>0.068*</b>	0.018	2.78	0.590	<b>0.550*</b>
Keeps family connected	0.008	–0.002	3.01	0.589	<b>0.549*</b>
Pass on way of life	–0.002	–0.002	2.85	0.640	<b>0.597*</b>
Uphold family legacy	–0.032	0.003	4.06	0.501	<b>0.467*</b>
Generations of family history	0.017	0.001	2.63	0.295	<b>0.275*</b>
Community of friendly neighbours	0.031 <sup>#</sup>	0.005	1.79	0.560	<b>0.522*</b>
Enjoy time with friends/family	<b>0.042*</b>	0.006	2.50	0.590	<b>0.549*</b>
Connect to professional network	0.003	–0.002	1.58	0.425	<b>0.396*</b>

Bold values indicate significance of \* $p < 0.05$ .

<sup>#</sup> $p < 0.10$ .



### 4.2 | Ordinary least squares regression analysis

Correlations are useful for examining individual relationships but they ignore the reality that place attachment is simultaneously informed by multiple meanings. In the OLS regression, meanings did an exceptional job explaining place attachment ( $F = 86.39, p < 0.001, R^2 = 0.87, R^2_{\text{adjusted}} = 0.86$ ). Of the 38 meanings used as independent variables, 12 were statistically significant (Table 1; see Supporting Information for full regression output). *Way of life* was most strongly related to place attachment—for every one-level increase in a landowner's belief that their land represents their way of life, place attachment increases by 0.18 (about a 2% increase) on average. *Way of life* was followed by *freedom to decide* ( $b = 0.17$ ) and *reducing stress* ( $b = 0.10$ ).

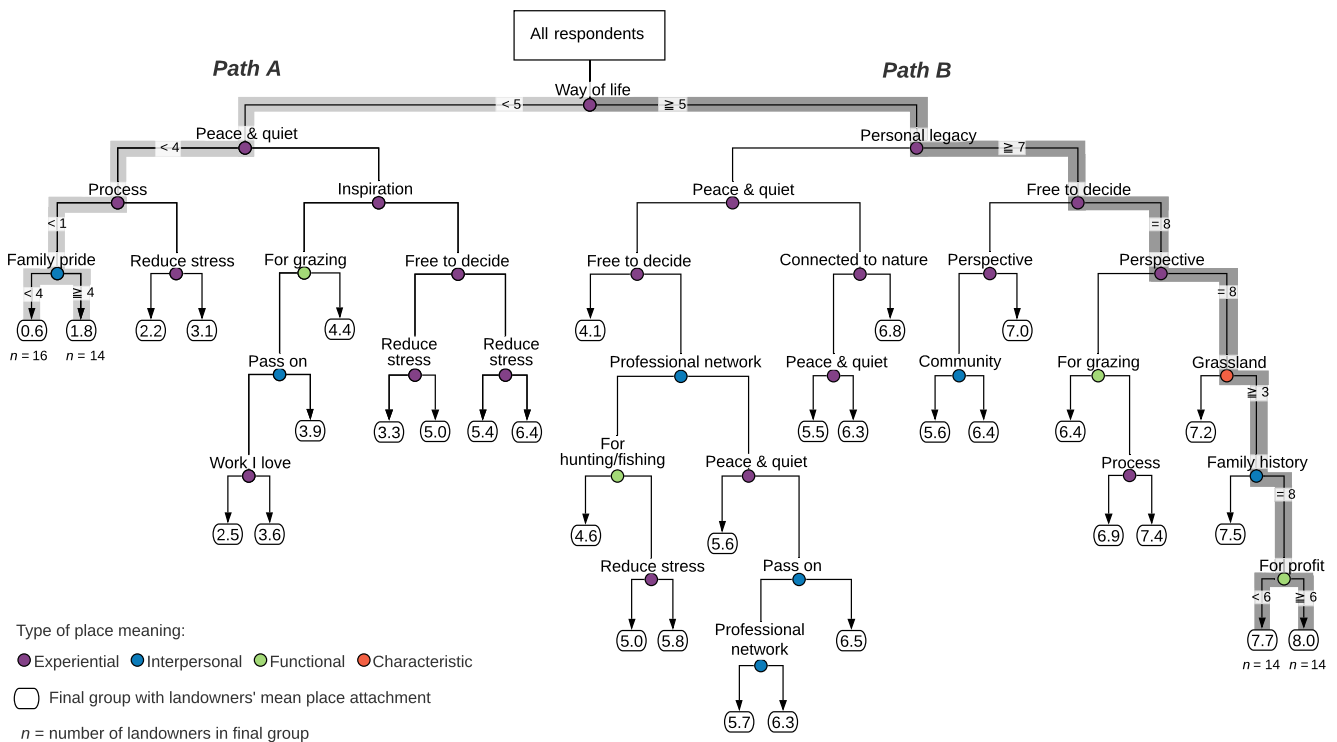
Although the regression model does well explaining place attachment, it is difficult to parse the exact contribution of each meaning. First, the partial omega-square values are very small indicating that no individual indicator explains a particularly large share of the variance in place attachment (mean omega-square = 0.009; median = 0.002). This indicates that most of the explained variance in the model is shared amongst meanings. Second, although the VIFs stop short of identifying major issues with collinearity, they do demonstrate at least moderate shared variance indicating that multiple meanings may be redundant in the model (Keith, 2019). Lastly, the structure coefficients show that a number of variables that could get credit for explaining variance do not. For instance, *peace and quiet* and *inspiration* have equal Pearson correlations with attachment ( $r_{\text{peace}} = 0.71; r_{\text{inspiration}} = 0.71$ ) and are correlated ( $r_{\text{peace.inspiration}} = 0.67$ ). In the OLS model, *peace and quiet* is statistically

significant ( $p < 0.01$ ) while *inspiration* is not ( $p = 0.13$ ). The structure coefficients identify *inspiration* as a predictor that could have received credit but did not, possibly because *peace and quiet* received credit for the shared variance it explained. Regression is useful to demonstrate that meanings are important determinants of place attachment; however, the issue of shared variance makes it difficult to understand how the meanings are structured with regard to attachment.

### 4.3 | Regression tree analysis

The optimal regression tree partitioned landowners into 33 terminal nodes that we refer to as groups (Figure 3; see Supporting Information for full regression tree output). The final groups of landowners had average levels of place attachment that ranged from very low (0.56) to very high (7.96) and contained between 10 and 27 people per group. The regression tree explained 86% of the variance in place attachment ( $R^2 = 0.86; \text{RMSE} = 0.72$ ). The  $R^2$  from the  $k$ -fold cross validation was 0.84 indicating a good fit between the training set and the test models.

The regression tree permits exploration of how multiple configurations of meanings can be associated with similar levels of place attachment and helps explain why place attachment varies. For example, Path A in Figure 3 highlights the place meanings held by landowners with the lowest levels of place attachment. They tended to not strongly believe that their land *represents their way of life*, held less than moderate beliefs that their place provides *peace and quiet*,



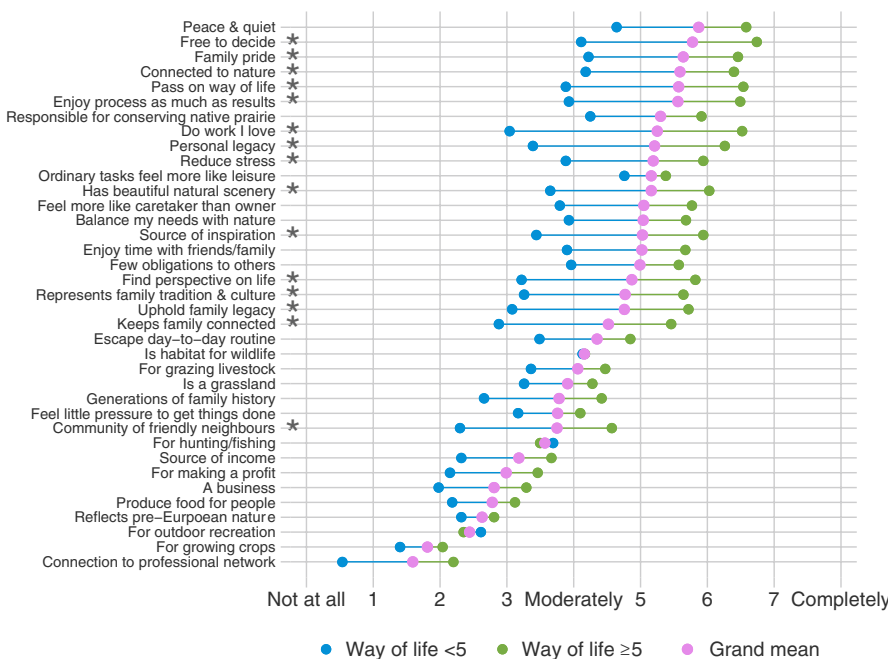
**FIGURE 3** Structure of sense of place using a regression tree to explain place attachment based on place meanings. Path A highlights the strength of place meanings held by landowners with the lowest place attachment. Path B highlights the strength of meanings held by landowners with the highest attachment

and did not at all *enjoy the process of working as much as the results*. Landowners with this combination of place meanings who believed that their land was at least a moderate *source of family pride* had an average place attachment of 1.79 ( $n = 14$ ), while those less likely to view their land as a *source of family pride* expressed essentially no attachment to their land (0.56;  $n = 16$ ). Conversely, landowners with the highest place attachment more strongly believed that their place *represents their way of life*, that it very strongly *represents their personal legacy*, is somewhere they are completely *free to decide things for themselves*, and that it is where they find *perspective on their life* (Figure 3, Path B). The subset of these landowners who characterized their place as at least somewhat of a *grassland*, very strongly believed that their land *represents generations of their family's history*, and held stronger beliefs that their land is *for making a profit* had an average place attachment of 7.96 ( $n = 14$ ). For those with the same combination of place meanings but a lesser belief that their land is *for making a profit*, the average place attachment was 7.70 ( $n = 14$ ).

The regression tree provides insight into variable importance. Recall that in the OLS regression, the structure coefficients identified that *inspiration* could have been a significant predictor of place attachment, if not for the shared variance with *peace and quiet* which actually received credit (Table 1). The regression tree shows that *peace and quiet* is important to understanding place attachment for about 70% of landowners, those who do not hold *way of life* as a strong place meaning and those who do have higher scores for *way of life* but do not strongly believe their land represents their *personal legacy*. On the other hand, *inspiration* is an important determinant of attachment for about 25% of landowners, the subset of landowners for whom *way of life* is less strongly held and *peace and quiet* is at least moderate. This demonstrates insight gained by using machine learning to complement OLS regression for exploratory analysis.

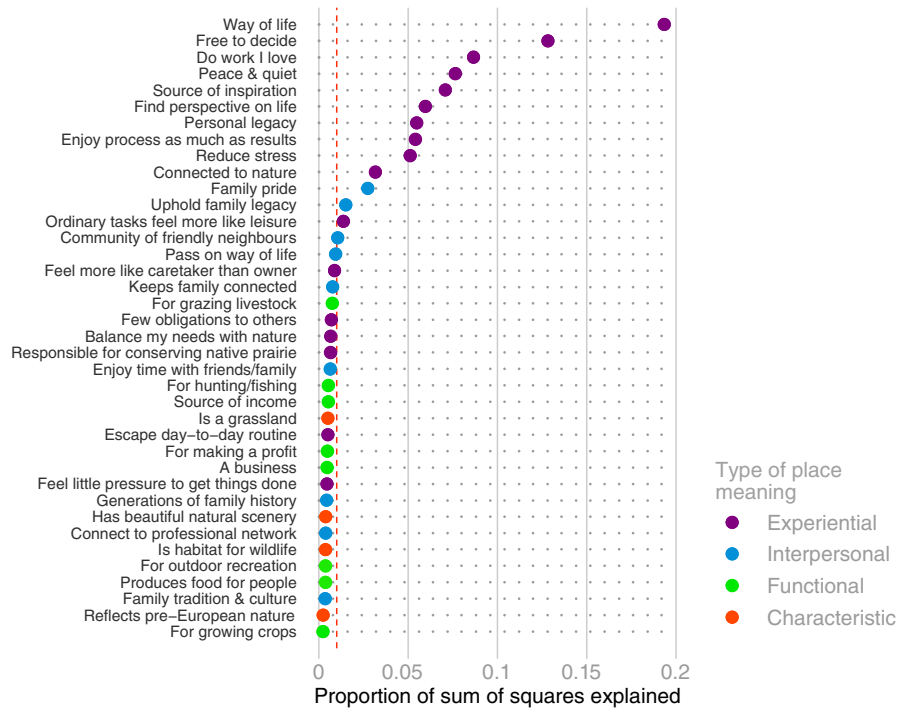
Along with delineating the pathways of meanings that relate to place attachment levels, the regression tree itself illustrates the relationship of place meanings to place attachment. The more important place meanings in relation to attachment are those with early splits (i.e. the top of the tree) thus affecting a larger portion of the sample. The tree is not symmetric indicating that the underlying process of forming place attachment from place meanings differs amongst landowner groups. These differences are commonly explained through the concept of interactions; however, non-symmetry may also indicate mediator/moderator effects or higher order nonlinearities (Lavery, 2012). Interactions between variables define most splits in the regression tree and can be seen in cases where the effect of one place meaning on place attachment depends on the value of another place meaning variable. For instance, the relationship between *personal legacy* and place attachment is dependent on whether or not *way of life* is a strongly held place meaning (Figure 3, Path B). For landowners who do not hold *way of life* as strongly, the interaction between *peace and quiet* and *way of life* becomes important for understanding attachment (Figure 3, Path A).

Echoing the importance of *way of life* in the OLS regression, *way of life* defines the first split in the regression tree. This split was based on whether the meaning was at least moderately strong ( $\geq 5$ ) or less strongly held ( $< 5$ ). Although there is some overlap, groups defined by the lower *way of life* split tended to have lower average place attachment (means ranging from 0.56 to 6.36), whereas groups defined by stronger belief in *way of life* tended to have higher levels of place attachment (means ranging from 4.10 to 7.96). We explored the meanings that characterize this initial split and found that a number of intergenerational, family heritage, and psychologically restorative meanings were at least 25% higher for landowners for whom *way of life* was moderate to strong (Figure 4). Landowners with higher ratings



**FIGURE 4** Differences in the strength of place meanings held by landowners with a moderate to strong belief that their land *represents their way of life* (green) and landowners with a weak to moderate belief in *way of life* (blue), as defined by the first split in the regression tree. Magenta points represent the grand mean for each place meaning. Place meanings with an asterisk (\*) indicate differences in meaning strength of at least 25% ( $\geq 2$  levels on scale from 0 to 8)

**FIGURE 5** The contribution of each meaning to the random forest model explaining place attachment as indicated by the proportion of the sum of squares explained. The red line identifies contributions <0.01



for *way of life* also held stronger meanings for all items except the functional meanings *for hunting/fishing* and *for other outdoor recreation*.

#### 4.4 | Random forest analysis

Although the regression tree enables detailed exploration of the landowners in this sample, a random forest analysis offers insights for both variable importance and future modelling to explain sense of place. Place meanings did extremely well explaining landowners' place attachment in the random forest ( $R^2 = 0.93$ , RMSE = 0.51). The key output of this analysis is the contribution of each meaning in explaining place attachment, with improved robustness over a single regression tree. Unequivocally, the strongest contributor to explaining attachment was the meaning *my place represents my way of life*, which accounts for about 19% of sum of squares explained (Figure 5). This was followed by autonomy, the belief that one is *free to decide for oneself* (13%). The top 10 meanings are all experiential and account for 80% of the sums of squares. Functional and place characteristic meanings all provide negligible contributions to the model (<1%). These findings indicate that in other similar landowner samples, experiential meanings may contribute the most to high levels of place attachment while functional and place characteristic meanings may contribute least.

### 5 | DISCUSSION

Privately held lands make up a large extent of the earth's surface; consequently, understanding how private landowners think about

and react to ecosystem change is critical to developing behaviour change and policy interventions (Capano et al., 2019). Sense of place holds promise for understanding people's behaviour because when place attachment is strong, social or ecological changes that threaten important place meanings can also threaten one's identity (Stedman, 2016). This threat can motivate a response such as increased stewardship and conservation behaviour. Threats to a shared sense of place can encourage collective action, while contested place meanings or different desired conditions can inhibit adaptation. Accordingly, sense of place can play an important role in understanding the trajectories of social-ecological systems; however, this role is predicated on the capacity to first understand people's sense of place.

While sense of place is theoretically rich, empirical applications to heterogenous populations across varied landscapes have been limited in their ability to account for the diversity and complexity inherent to person-place connections. Our meaning-dependence framework addresses these concerns by rethinking how sense of place is conceptualized and measured. By integrating the concept of resource dependency into our consideration of place dependence and the place meanings that landowners may hold, we address a number of issues highlighted by Eaton et al. (2019). We conceptualized the place dependence concept as inherent to each meaning rather than a global evaluation of one's place. As such, place meanings not only reflect beliefs people hold, but also the degree to which people rely on a setting to provide or fulfil a particular meaning. We also measured a broad range of place meanings at greater specificity than is often done in quantitative research. By splitting higher order concepts like psychological restoration and identify into their theoretically defined components for measurement, we reduced error stemming from respondents' individual interpretations of broad evaluations of what it

means to feel 'restored' or to 'identify' with a place, thereby improving data quality. Finally, we formulated the multiple items that constitute place attachment as meanings themselves and measured them along the same dimensions of representativeness and dependence applied to explanatory variables. This conceptual compatibility removes an artificial source of error and improves explanatory power (Fishbein & Ajzen, 2010).

Place meanings, as we conceptualized and measured them, performed extraordinarily well in explaining place attachment for our sample, and the combination of analytical methods we used provides in-depth insight into the composition of sense of place. Our results support conceptualizations of sense of place as a set of beliefs (place meanings) that foster landowners' feelings of connection to their land (place attachment). Overall, we found that the relationship between place attachment and meanings was overwhelmingly characterized by shared variance (i.e. intercorrelations between meanings) and interactions. Many meanings are moderately correlated with each other, and a single meaning's relationship with attachment frequently depends on other meanings.

Our results suggest that not all place meanings are equal. Experiential meanings were the strongest drivers of place attachment, while place characteristic and functional meanings contributed minimally. The regression tree and random forest results suggest the possibility of a hierarchical relationship amongst categories of meanings. Specifically, experiential meanings may be the most proximate to place attachment followed by interpersonal meanings. Future research on a potential hierarchy of meanings should investigate place characteristic and functional meanings as possible antecedents to the interpersonal and experiential meanings held by individuals. That is, experiential meanings may at least partially mediate the statistical relationship between place attachment and both place characteristic and functional meanings. This follows Stedman's (2003) premise that the physical setting contributes raw materials that influence the formation of place meanings that underlie attachment. Measuring the biophysical environment as characteristic and functional place meanings provides a means to compare how meanings regarding the physical setting relate to meanings associated with personal and social experiences, and examine the relationship of each type of meaning with overall place attachment. This approach supports research efforts seeking to understand the joint production of sense of place through external (e.g. environmental features) and internal factors (e.g. attributes of the individual; see Raymond, Kyttä, & Stedman, 2017).

An inspection of specific place meanings also suggests a hierarchy of meanings. *Way of life* captured substantial variation in place attachment and was central to explaining place attachment on private lands. While a common term in the private landowner literature, *way of life* has not received substantive attention as a concept. We based our item on Marshall's (e.g. 2011) measurement of occupational attachment; however, we broadened the framing to '*my place represents my way of life*'. Previous considerations of *way of life* are largely presented in contrast to a financially based perspective. For instance, Walter (1997) juxtaposes *way of life* and a business

orientation as possibly two separate concepts. This is supported by Michalos (2014), who equates *way of life* with *lifestyle*, defining the latter as stable patterns of behaviour that express one's cultural values (Spellerberg, 2014). Blank (2002, 2005) uses this same dichotomy, employing an economic lens to suggest that agriculture as a business reflects an explicit focus on profit, whereas agriculture as a *way of life* incorporates lifestyle benefits, focusing on happiness, or, in economic terms, utility. Vanclay (2004) characterizes *way of life* as a socio-cultural practice that involves making a living, and also includes a larger calling that has 'a meaning far deeper than almost any other occupation' (p. 213). Walter (1997) captures this idea arguing that some farmers trade-off economic rewards for non-economic benefits of 'being one's own boss' (autonomy), 'making friends' (belongingness), and 'doing good work' (competence; p. 50). From a broader theoretical standpoint, Savolainen (1995, p. 262) posits that *way of life* is a person's preferred 'order of things', guiding everyday choices beyond one's occupation such as the ratio between work and leisure, modes and habits of consumption, and the nature of one's hobbies.

The ability of *way of life* to incorporate components of one's preferences for what constitutes a good life makes it a worthy relational value because it considers the relationships landowners hold with their place rather than only the intrinsic values or extrinsic benefits they derive from it (Chan et al., 2016). In our data, *way of life* differentiates landowners who are more involved in and more committed to the identity and occupation of farming and ranching (see Supporting Information). While occupation may be related to *way of life*, this concept spans both livelihood and lifestyle to encompass a person's choices and preferences for everyday routines and activities (Savolainen, 1995). We found that landowners who held *way of life* as a stronger place meaning held higher values for almost all other place meanings, especially experiential and interpersonal meanings reflecting personal and social psychological connections to the land (see Figure 4). These landowners also tended to have higher levels of place attachment. *Way of life* distinguishes the subset of landowners with higher place attachment and a higher number of valued place meanings, supporting Wynveen et al.'s (2012) proposition that place attachment increases as the diversity and intensity of place meanings increase.

The relationships between experiential place meanings and attachment, which is comprised of an emotional bond and self-identity, suggests the relational nature of sense of place on private lands. Experiential meanings encompass the personal psychological beliefs and feelings of dependence on those beliefs that make the physical setting personally fulfilling, and are neither wholly instrumental nor completely intrinsic. The sense of place developed by rural landowners is the culmination of the land's characteristics, how an individual interacts with that land, the meanings and associated dependence then ascribed to the land, and feelings of attachment that may result. Developing from feedbacks as a result of continued interaction, this phenomenon may be better conceptualized as a *relationship with* the land rather than a *connection to* the land. This ongoing relationship

likely contributes to the way landowners perceive, interpret, and adapt to ecological change on the landscape (Masterson, Stedman, et al., 2017; Stedman, 2016). Befitting a relationship, sense of place may consist of stable, enduring meanings and attachments that guide reactions to change (Masterson, Stedman, et al., 2017) as well as dynamic, evolving aspects formed through continued interactions (Raymond et al., 2017). We suggest that further research using sense of place to understand landowner responses to ecological transformation consider the degree to which landowners identify their relationship with their land as constituting their way of life.

Research on sense of place and the relationship between place meanings and place attachment can benefit from nonparametric machine learning approaches such as regression trees and random forests. These techniques complement parametric approaches and provide ways to examine sense of place that can capture heterogeneity in the degree to which individuals value and rely on a place for various meanings. They tend to perform better for data that have substantial levels of shared variance, are skewed, multimodal, or categorical because they make no assumptions about the distributions of the predictor variables (Hindman, 2015; Lewis, 2000). For data exploration, regression trees may be particularly useful to characterize the combinations of meanings and levels of attachment that comprise different *senses* of place, providing insights into potential sources of conflict and barriers to collaboration in the face of social–ecological change (Devine-Wright, 2009; Yung et al., 2003). For predictive modelling, random forests identify the place meanings that should be important to similar populations. Understanding the potentially limited generalizability of our findings, we hypothesize *way of life*, *freedom to decide* (autonomy), and *doing work one loves* (an aspect of psychological flow) as key meanings for future research to explore in other landowner populations. Similar to other research on place attachment (e.g. Devine-Wright & Howes, 2010; Korpela, Hartig, Kaiser, & Fuhrer, 2001), meanings related to psychological restoration such as *peace and quiet*, *perspective on life*, *source of inspiration*, and *stress reduction* may also be important. We are confident in our meanings as good indicators of sense of place on private lands because we found similar results across all methods.

We applied our meaning-dependence framework to private landowners in a working landscape, and this approach provides a template for future sense of place research in other contexts. Measuring place meanings along two dimensions and allowing respondents to indicate their belief and dependence on meanings independently enables nuance and depth that more closely approximates the way people form connections to places (e.g. Davenport & Anderson, 2005). This helps bridge gaps identified between the qualitative realm, where most sense of place theory was developed, and the quantitative realm, where oversimplified measures can fail to capture the richness and complexity of person–place connections (Stedman, 2003). Identifying importantly held place meanings is critical as people are expected to perceive and respond to place change based on how compatible or threatening a given change is to the

specific place meanings they hold (e.g. Devine-Wright, 2009; Quinn et al., 2019). We combined the representativeness and dependence measures to ascertain the overall strength of each place meaning. Future research may build on this approach by exploring how these two dimensions independently relate to place attachment and subsequent place-related behaviour. Additionally, measuring other place constructs at the meanings level as opposed to the global level may enhance place-based research by improving correspondence between measures. For example, place satisfaction can be an important intermediary construct to understand place-protective behaviour (Stedman, 2002, 2003). Identifying a person's satisfaction with the ability of a place to provide specific meanings may highlight the presence or absence of motivations for action. Although strength of connection to a place is usually framed in terms of a positive attachment, another next step includes the measurement of place meanings along a dimension of valence to understand the polarity of influence (i.e. positive or negative) that individual meanings have on one's sense of place (Manzo, 2005).

## 6 | CONCLUSION

The rapid pace of current global change can threaten the heritage and cultural resources associated with both traditional landscapes and built environments (Bott, 2018). Sense of place research can identify the place-based connections and relationships central to vulnerable populations providing insights into human welfare and potential responses to change. Approaches that 'make these phenomena more tangible and measurable without neglecting the subjective, qualitative nature of sense of place' enable better engagement with and inclusion of person–place dynamics in natural resource management (Masterson, Stedman, et al., 2017, p. 49). Future research using sense of place to understand the human role in social–ecological change may be more productive by recognizing that multiple configurations of place meanings simultaneously exist, each engendering levels of attachment.

Continued refinement of the sense of place concept is needed to better understand how sense of place facilitates or constrains vulnerability and the capacity to adapt in the face of social–ecological change. Place attachment is hypothesized to lead to behavioural responses when importantly held meanings are threatened, triggering changes in people's experiences and satisfaction with a setting (Devine-Wright, 2009; Stedman, 2002; Twigger-Ross & Uzzell, 1996). However, behavioural thresholds may exist whereby additional concepts such as exposure to change, beliefs about consequences, conservation ethics, and perceived threat mediate the relationship between sense of place and engagement in place-protective behaviour (Adger, 2006; Devine-Wright & Howes, 2010; Eaton et al., 2019; Jacquet & Stedman, 2014; Zajac, Bruskotter, Wilson, & Prange, 2012). Understanding when sense of place leads to behaviour change requires understanding the multiple ways meanings create, define, and maintain what a person considers an appropriate relationship with a place.



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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHORS' CONTRIBUTIONS

K.R. and M.G.S. designed the research and collected the data; M.G.S. and V.A.T. led data analysis; K.R. led writing the manuscript. All authors provided critical contributions to the manuscript and have given final approval for publication.

## DATA AVAILABILITY STATEMENT

Our de-identified survey data are archived with VTechData, the data repository for Virginia Tech: <https://doi.org/10.7294/ZCT7-YQ08> (Sorice & Rajala, 2020). Data will be under embargo until 1 June 2021, due to ongoing publishing activity.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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