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Intentions of Landowners Towards Active Management for White-tailed Deer Hunting in the Forest-Grassland Transitional Ecoregion of the South-Central USA

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Abstract:	The forest-grassland ecotone of the south-central USA is a mixture of forest, savanna, and tallgrass prairie. The ecotone is increasing in woody plant dominance due to the exclusion of fire and other anthropogenic factors. Active management, such as prescribed fire and thinning, can restore savanna and prairie ecosystem to maintain a full suite of ecosystem services, and creates suitable habitat for wildlife such as white-tailed deer (Odocoileus virginianus). Active management, however, comes with the cost of management and acceptance of management tools. Deer hunting is a vital source of revenue generation to offset the landowner's management cost in the region. We studied Oklahoma landowners' perceptions regarding active and sustainable management of forest and rangeland for deer habitat using two established theories of reasoned action and planned behavior as well as expanded theories adding moral norms. We analyzed mailed survey data using structural equation modeling. We found that subjective norms and perceived behavior control significantly affected deer hunting intention when moral norms were introduced into the model. Attitudes independently significantly affected intentions of deer hunting but were negatively correlated with the intentions. The study suggests that landowners have positive social pressure and are interested towards active management but associated financial burden and risk could be shaping negative attitudes.

Title:

Intentions of Landowners Towards Active Management for White-tailed Deer Hunting in the Forest-Grassland Transitional Ecoregion of the South-Central USA

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Drs Dewil, Evans, and Zhang

We would like to submit an original research article "**Intentions of Landowners Towards Active Management for White-tailed Deer Hunting in the Forest-Grassland Transitional Ecoregion of the South-Central USA**" for publication in the Journal of Environmental Management.

We believe that our manuscript will make a significant contribution to the literature because it studied the landowners' intentions towards the actively managing land for deer hunting using theory of reasoned action and theory of planned behavior and expanded theories by adding moral norms. This paper compared two theories and expanded them which is a noble approach in the human dimension of natural resource management research. Also, the intentions towards active management were also not studied in past literatures which is done by this research. We believe that these novelty in the research and the focus of research in the management of natural resource makes this paper a fit into the scope of your journal.

This manuscript has not been published or presented elsewhere in part or in its entirety and is not under consideration by any other journal submission. There are no conflicts of interest to declare.

We are looking forward to your decision and appreciate your consideration of our work.

Sincerely,

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Research Highlights

- Active management is vital to maintain ecotone of south-central USA.
- Structural equation model was used to analyze data.
- Perceived behavior control, subjective norms, and moral norms were positive.
- Experience of landowners shaped negative impacts of attitudes.
- Results highlights importance of outreach and extension related activities.

Intentions of Landowners Towards Active Management for White-tailed Deer Hunting in the Forest-Grassland Transitional Ecoregion of the South-Central USA

Abstract

The forest-grassland ecotone of the south-central USA is a mixture of forest, savanna, and tallgrass prairie. The ecotone is increasing in woody plant dominance due to the exclusion of fire and other anthropogenic factors. Active management, such as prescribed fire and thinning, can restore savanna and prairie ecosystem to maintain a full suite of ecosystem services, and creates suitable habitat for wildlife such as white-tailed deer (*Odocoileus virginianus*). Active management, however, comes with the cost of management and acceptance of management tools. Deer hunting is a vital source of revenue generation to offset the landowner's management cost in the region. We studied Oklahoma landowners' perceptions regarding active and sustainable management of forest and rangeland for deer habitat using two established theories of reasoned action and planned behavior as well as expanded theories adding moral norms. We analyzed mailed survey data using structural equation modeling. We found that subjective norms and perceived behavior control significantly affected deer hunting intention when moral norms were introduced into the model. Attitudes independently significantly affected intentions of deer hunting but were negatively correlated with the intentions. The study suggests that landowners have positive social pressure and are interested towards active management but associated financial burden and risk could be shaping negative attitudes.

Keywords:

Theory of Planned Behavior, Theory of Reasoned Action, Moral Norms, Prescribed Fire, White-tailed Deer (*Odocoileus virginianus*).

1. Introduction

The forest-grassland ecotone of the south-central USA, originally spanning from southern Illinois to Texas, consists of a mosaic of upland forests, savanna, and tallgrass prairie (Hallgren et al., 2012; Joshi et al., 2019b). The ecotone regularly experiences disturbances such as drought (Clark et al., 2007; Hallgren et al., 2012), invasive species (Joshi et al., 2019b; Starr et al., 2019), anthropogenic factors such as urbanization (Joshi et al., 2019b), and climate change (Joshi et al., 2019b; Starr et al., 2019). The transitional nature of the ecoregion makes it more vulnerable to climate change (Füssel, 2007) and changing management regimes can cause large changes in land cover as evidenced by shifting vegetation dynamics towards closed-canopy forests (Hoff et al., 2018a; Hoff et al., 2018b; Joshi et al., 2019b). Fire exclusion, in particular, leads to an increase in forest cover, abundance of mesophotic, fire-sensitive hardwoods species, and fire-sensitive eastern redcedar (ERC) (*Juniperus virginiana*) which potentially increase wildfire risk (Hoff et al., 2018b).

Active management using prescribed fire and thinning are important tools to restore this region's characteristic features, increase resiliency against changing climate, and build self-sustaining ecosystem (Clark et al., 2007; Joshi et al., 2019a; Starr et al., 2019). Management costs and potential liabilities from using fire, however, have restricted the application of active management tools (Starr et al., 2019). Previous research in this region suggest that healthy and resilient forests provide an opportunity to increase revenue which in turn drives active management (Joshi et al., 2019b; Starr et al., 2019). For example, prescribed burning in combination with herbicides can be used to create open forest structure and more diverse seasonal forage for white-tailed deer (*Odocoileus virginianus*)

(Jones et al., 2009; Leslie Jr. et al., 1996). Given the context of declined production of quality timber due to encroachment of less valuable timber species (Riddle, 2019) such as ERC (Clark et al., 2007; Kaur et al., 2020) and large economic benefit of wildlife management at the local and state level (Poudyal et al., 2020), wildlife management can be an important motivation for active management of forested and non-forested ecosystems in this region.

Among wildlife management activities, deer hunting is an important cultural tradition transferred from generation to generation (Byrd et al., 2017; Demarais, 1992; Lovell et al., 2004; Mann, 2002). Besides, deer hunting is used to harvest game (Byrd et al., 2017; Hrubes et al., 2001) and provides psychological (Hrubes et al., 2001), social (Byrd et al., 2017; Hrubes et al., 2001), emotional, mental, and physical (Hrubes et al., 2001) benefits to the hunters. Deer hunting also provides important economic benefits and serves as a vital wildlife management tool (Byrd et al., 2017; Peterson, 2004). The beliefs, past experiences, and social pressure play important role in shaping landowners' attitude, and intentions towards active management of ecosystem (Ajzen, 2020; Madden et al., 1992). This paper, thus, addresses the question: how do landowners' beliefs, attitudes, and norms about sustainable management of forest and rangeland for deer habitat impact their intentions for the active management of ecosystem for deer hunting.

Theory of reasoned action (TRA) and theory of planned behavior (TPB) were used for this research. Both theories describe the how human intentions are shaped based on their belief, norms, and past action (Ajzen, 2020). TRA and TPB are widely used in comparative study (Daigle et al., 2010; Hrubes et al., 2001; Rossi and Armstrong, 1999), and were specifically applied to deer hunting (Daigle et al., 2010), willingness to pay (Lopez-Mosquera et al., 2014), and several other purposes summarized by (Ajzen, 1991, 2011). No

previous study, however, to the best of our knowledge, used TRA and TPB to study landowners' intentions towards active management of forest and rangeland for deer habitat management and expanded these theories by including moral norms.

This research contributes to existing knowledge in three ways. First, this research studied landowners' intentions of applying active management for deer hunting because landowners can generate more revenue from hunting leases by actively managing their land to improve deer habitat. Second, limited social science research explored the interrelationship between values, attitudes, norms, and behavior intentions in this grassland-forestland tension zone of the United States; TRA and TPB were used to study inter-relationships between above mentioned human psychology. Third, TRA and TPB were expanded by adding moral norms into both theories as suggested by Ajzen (1991). Past researchers highlighted the importance of improvement, refinement, and modifications (Lopez-Mosquera et al., 2014; Miller, 2017) of these theories by adding new predictors, testing concepts and models, and merging theories with additional attributes (Miller, 2017). Moral norms affect subjective norms and perceived behavior control of an individual (Heidari et al., 2018; Lopez-Mosquera et al., 2014). This paper, thus, tested four models—two theories with, and without moral norms— to study intentions towards active management of forest, and rangeland for deer habitat management.

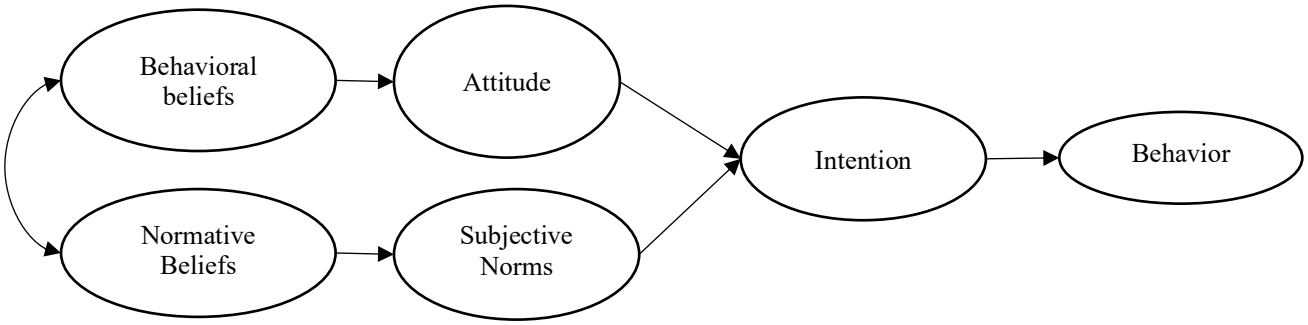
2. Methods

2.1 Theoretical framework: theory of reasoned action (TRA) and theory of planned behavior (TPB)

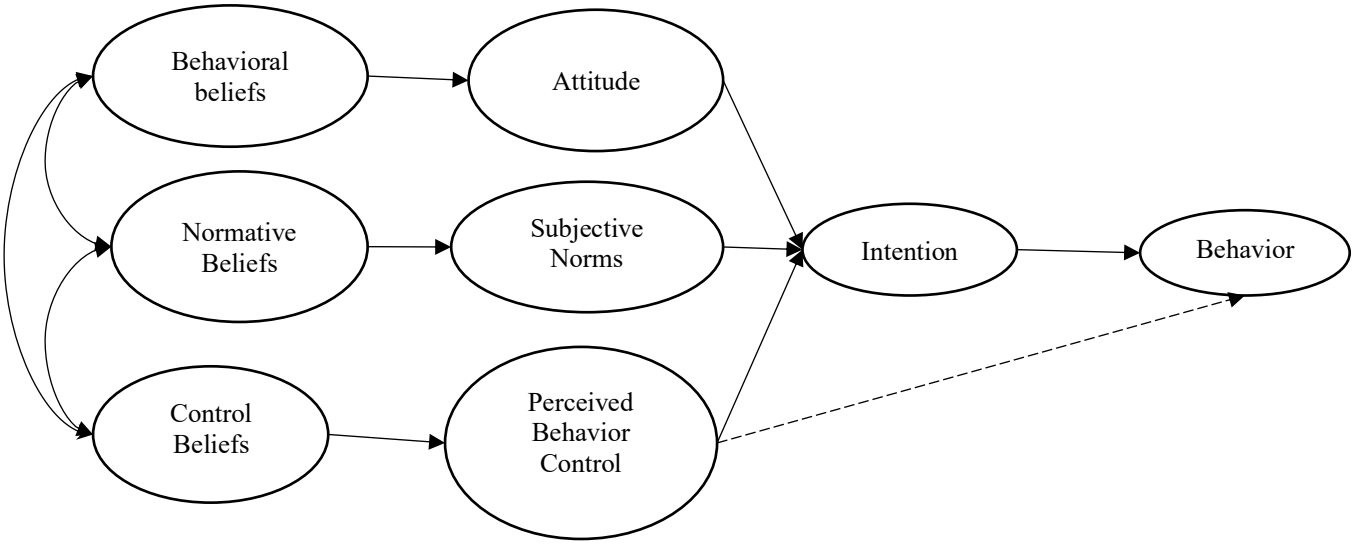
Theory of reasoned action proposes that human intention is an immediate precursor to an action. The action originates from a belief that performing an activity leads to the intended outcome (Madden et al., 1992), assuming the action is under the volitional control of an individual. The theory, however, did not account for an action that the individual intends to perform but is not under the actual control (i.e., volitional control) of the individual (Ajzen, 2002). This limitation involving volitional control is addressed in TBA by adding perceived behavioral control as one of the factors affecting the behavioral intention of an individual (Fishbein and Ajzen, 1975; Madden et al., 1992; Rossi and Armstrong, 1999). Theory of planned behavior, thus, can be understood as addition of perceived behavioral control to TRA and TPB reduces to TRA when the behavior is under the volitional control (Ajzen, 2020). The theoretical models (Figure 1) for this paper were adopted from (Ajzen, 1991) and (Madden et al., 1992).

The theory of planned behavior assumes that a belief towards an action shapes a person's attitude and norms which further shapes intentions toward the action. Positive beliefs, attitudes, norms, and intentions towards an action motivates an individual to perform given action (Ajzen, 1991, 2002, 2011). The beliefs can be categorized into behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs originate from the experience of an individual while performing an action which shapes a person's attitude towards an action. Normative beliefs originate from social standards, values, norms, and pressure which shapes subjective norms of an individual. The control beliefs shape perceived behavioral control which is a perception of an individual that action is

under the volitional control of the individual (Ajzen, 2002). This research was designed assuming that landowners used their beliefs to form attitudes, subjective norms, perceived behavior, and intentions while responding to respective survey questions.



(a)



(b)

Figure 1: (a) Theory of Reasoned Action and (b) Theory of Planned Behavior.

2.2 Survey Design and Administration

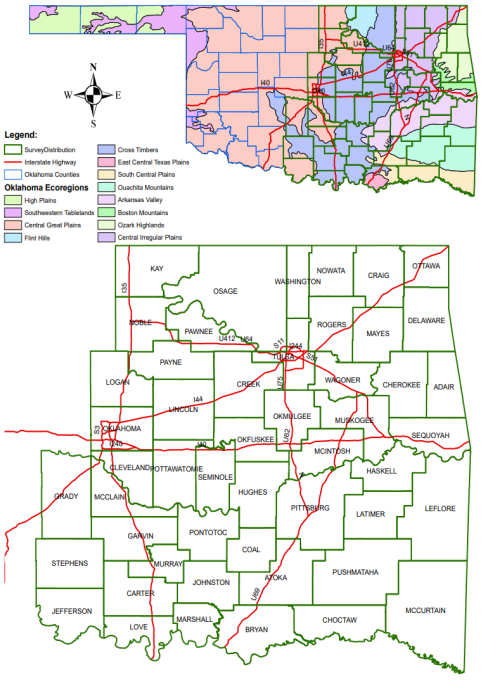


Figure 2: Study region: map of Oklahoma representing various ecoregions (top) and counties receiving surveys (bottom).

The mailed survey was conducted following the method suggested by Dillman et al. (2014). The study area represented a portion of the transitional ecoregion of south-central USA in Oklahoma (Figure 2). A mailing list of landowners in Oklahoma owning 160 acres (65 ha) or more land with forest and rangeland was obtained from a commercial vendor, Dynata (https://www.dynata.com/). The survey was bulk-mailed to 2,500 randomly selected Oklahoma landowners from forest-grassland transitional ecoregion. The survey package included a personalized cover letter, questionnaire, and prepaid return envelope. Out of selected landowner, 16 did not participate because of various reasons such as deceased, refused to participate, no longer in business, and inaccurate location identifier, reducing total sample to 2,484.

Two rounds of surveys with a gap of about two months, each followed by reminder postcards after about a month of survey mailing, were sent to the randomly selected landowners. A second round of survey and postcards were sent to only those landowners who did not respond during the first round of mailing. A total of 508 completed surveys were received from the two lots of mailing and postcard reminders with the final response rate of 20.45%. The demographics of the landowners were compared with National Woodland Owner's Survey database (Caputo and Butler, 2021). Early and late response

biases were conducted using chi-square tests on age, gender, income, education, and race among landowners' response received after first and second lots of survey and postcards.

The questions were asked as 5-point Likert scale (1 as strongly disagree to 5 as strongly agree) for all variables except those representing intentions. Intentions were asked as landowners' willingness to pay (USD), travel distance (miles) to alternate hunting site with similar quality, and interest (yes/no) in active management of their land. The observed variables loaded as intentions in the model were normalized by dividing the difference of the mean and observed value for each observation by the standard deviation of the variable (Urbano et al., 2019) because of difference in measurement scale. Mean and standard deviation before standardization were reported for all standardized and non-standardized variables. Cronbach alpha values were obtained after standardization for standardized variables because standardized variables are used in structural equation models (SEM). Missing observations were removed on a list-wise basis resulting into 177 observations to use in the SEM models, calculating fit indices, factor loadings, Cronbach alpha values, mean, and standard deviation of observed variables.

2.3 Hypothesis

We tested the following hypotheses related to the TRA, TPB, and moral norms regarding active management of forest and rangeland for deer habitat:

Hypothesis 1 (H_1): Positive subjective norms shape positive intentions.

Hypothesis 2 (H_2): Positive attitude shape positive intentions.

Hypothesis 3 (H_3): Positive attitudes shape positive moral norms.

Hypothesis 4 (H_4): Positive perceived behavior control shape positive intentions.

Hypothesis 5 (H_5): Positive subjective norms shape positive moral norms.

Hypothesis 6 (H_6): Positive perceived behavior control shape positive moral norms.

Hypothesis 7 (H_7): Positive moral norms shape positive intentions.

2.4 Structural Equation Model (SEM)

2.4.1 Model Fit Indices and Internal Validity

The internal validity of measurement variables was determined using Cronbach alpha. A Cronbach alpha value above 0.60 (Coon et al., 2020; Cronbach, 1951) was used as an indicator of internal consistency of variables loading in the latent constructs. The model fit indicators were determined by using several model fit indicators such as the root mean squared error or approximation (RMSEA, < 0.05) (Schreiber, 2017; StataCorp, 2017), standardized root mean squared residual (SRMR, ≤ 0.08) (StataCorp, 2017), Comparative fit index (CFI, ≥ 0.95) (Schreiber, 2017; StataCorp, 2017), and coefficient of determination (CD, ≥ 0.95) (StataCorp, 2017). Akaike Information Criteria (AIC), the smaller the better, was used for model comparison (StataCorp, 2017). Model fit indicators were obtained after running each SEM model. RMSEA estimates population error, CFI does baseline comparison, and SRMR and CD compares size of residual. CD is analogous to R^2 for the model (StataCorp, 2017).

2.4.2 Path analysis

Structural equation model was used for the study. Structural equation model has endogenous or outcome variables (variables with arrows pointed towards them) and exogenous or independent variables (variables with arrows pointed away from them) (Anderson and David, 1988; Gunzler and Morris, 2015). SEM is a two-step modeling approach using a confirmatory factor analysis method and specifies the relationship of observed variables to their respective latent variables which can intercorrelate freely. Paths in SEM

are structured based on underlying theories (Anderson and David, 1988). The linkage between endogenous and exogenous variables are shown by structural equations. The measurement error and the latent variables are modeled by measurement equations (Gunzler and Morris, 2015). These two sets of equations can be written in general matrix form. The matrix form for the measurement equations is:

$$y = \mu_y + \Delta_y \eta + \varepsilon \qquad (1)$$

$$x = \mu_x + \Delta_x \xi + \delta \qquad (2)$$

where, $\boldsymbol{\xi}$ represents a vector of r unobserved latent exogenous variables measured by the q observed variables **x**. $\boldsymbol{\eta}$ is a vector of m latent endogenous variables measured by the p observed variables $\boldsymbol{y}$. $\boldsymbol{\mu}_y$ and $\boldsymbol{\mu}_x$ are vectors of intercepts, $\boldsymbol{\Delta}_y$ and $\boldsymbol{\Delta}_x$ are matrices of slopes also referred to as loading matrices and, $\boldsymbol{\varepsilon}$ and $\boldsymbol{\delta}$ are residual terms in respective equations for **y** and **x**. $\boldsymbol{\mu}_y$ and $\boldsymbol{\varepsilon}$ have dimensions of p*1, $\boldsymbol{\mu}_x$ and δ have dimensions of q*1, and $\boldsymbol{\Delta}_y$ and $\boldsymbol{\Delta}_x$ have dimension of $q*r$ (Gunzler and Morris, 2015).

The structural model that relates unobserved latent variables to each other can be expressed as:

$$\eta = \mu_\eta + B\eta + \Gamma\xi + \zeta \qquad (3)$$

where, μ_η is m*1 dimensional matrix of intercepts for the unobserved endogenous latent variables, $\boldsymbol{B}$ is an $m*m$ matrix of slopes of the unobserved endogenous latent variables to each other, $\boldsymbol{\Gamma}$ is $m*n$ matrix of slopes for the unobserved exogenous latent variables, and $\boldsymbol{\zeta}$ is m*1 vector of random error for unobserved endogenous latent variables (Gunzler and Morris, 2015).

Four different models—TRA and TRA with moral norms (henceforth, TRA-moral) and TPB and TPB with moral norms (henceforth, TPB-moral) were fitted using SEM. To

develop TRA-moral, TRA was extended by adding an additional path from subjective norms to intentions through moral norms. Similarly, TPB-moral was developed adding two additional paths from subjective norms and perceived behavior control intentions through moral norms resulting. Structural equation models were fit using "*sem*" command in STATA 15.1 which fits linear SEMs using maximum likelihood estimation method (StataCorp, 2017). Maximum likelihood estimators have asymptotic, unbiased, consistent, and efficient property under the normality assumption of observed variables (Anderson and David, 1988).

Structural equation models were fit after obtaining acceptable range of internal consistency and factor loadings in each latent variable for all four models. Observed variables were dropped if an acceptable range of internal consistency and factor loading were not obtained. The same set of observed variables (N = 177) were used in all four models to form latent constructs. Command *sem* assumes that observed endogenous, observed exogenous variables, latent endogenous, and latent exogenous variables were jointly distributed normally with mean (μ) and variance-covariance matrix ($\sum$) (StataCorp, 2017). The coefficients reported are standardized coefficients which are correlation coefficients and can be interpreted as change in one variable given a change in another, both measured in standard deviation units (StataCorp, 2017).

3. Results

3.1 Demographics of Respondents

Most of the survey respondent were white males with formal education level of high school or above, 21-94 years old. Most were involved in farming or ranching, with annual

income of $25,000 or higher. Participants in survey were 86.62% male and 13.45% female, 82.62% white American, 11.80% native American, and 5.58% multiple races. About half, 48.36%, of the respondents reported their primary job as farmers/rancher, 25.60% as retired, 7.66% as business, 4.16% as working class (laborious) jobs, 2.63% as medical jobs, and 11.59% of the responders held other jobs unidentified in the survey. Average age of respondents was 67.44 (SD = 12.20) years. The percentage of respondents with high school or General Educational Development (GED) degree was 25.90%, some college experiences was 18.90%, associate or technical degree was 11.04%, bachelor's degree was 21.66%, and graduate degree was 20.38%. The age, gender, race, education, and income proportions from the survey data were similar to the National Woodland Owners Survey Database. The early and late response bias conducted using above mentioned demographics did not show response bias among responders from first and second lots of survey and postcards mailing.

3.2 Measurement and Structural Variables, and their Factor Loadings

Cronbach alpha and factor loading (λ) of observed variables in their respective latent variables, mean, and standard deviation are presented in Table 1. Measurement variables are variables observed in the survey. Structural variables are latent variables. Subjective norms (Cronbach α = 0.89) consisted of observed variables *e1value, e1diverse, e1support,* and *e1livable* variables. Attitudes (Cronbach α = 0.87) consisted of variables *e3manage*, *e3effort*, *e3wilder*, and *e3overall*. Moral norms (Cronbach α = 0.82) were represented by variables *e2respect, e2maintain* and *e2invest*. Cronbach alpha value of subjective norms, attitudes, and moral norms were above the value suggested by Cronbach (1951). Perceived behavior control (Cronbach α = 0.52) consisted of variables *e1resource*

and *e1improve.* Lastly, intentions (Cronbach α = 0.38) consisted of *a7wtp, a9altdist*, and *c6interst*. Cronbach alpha values of perceived behavior and intentions were slightly below the suggested value of internal consistency.

Table 1: Validity of structural variables, descriptions, and descriptive statistics of measurement variables.

Measurement Variables in SEM Models	**Factor Loading (λ) (N = 177)**	**Mean (St. Dev.) (N = 177)**
Subjective Norms (*SUBNORM*): Cronbach Alpha (α) = 0.89		
e1value: Sustainable management of forest, rangeland and deer habitat is important to the people I value most.	0.77	3.81 (1.08)
e1diverse: My family and friends think that forest, rangeland, and deer habitat management could enhance plant and animal diversity.	0.83	3.61 (1.13)
e1support: My family and friends are supportive of forest, rangeland, and deer habitat management activities.	0.91	3.83 (1.04)
e1livable: My family and friends think that forest, rangeland, and deer habitat management would make our environment more livable.	0.81	3.57 (1.12)

Perceived Behavior Controls (*PBC*): Cronbach Alpha (α) = 0.52		
e1resource: I have resource and opportunities to manage my land for forest, rangeland, and deer habitat management.	0.46	3.49 (1.17)
e1improve: I think that I can improve forest, rangeland, and deer habitat on my property by actively managing them.	0.72	3.96 (0.99)
Moral Norms (*MORAL*): Cronbach Alpha (α) = 0.82		
e2respect: I give respect and courtesy to people who are involved in forest, rangeland, and deer habitat management.	0.68	4.25 (0.85)
e2maintain: I feel that I should actively manage forest, rangeland, and deer habitat on my property to maintain deer habitat for deer and wildlife.	0.92	3.97 (0.99)
e2invest: I feel honored to invest money, time, and resources to manage forest, rangeland and deer habitat for deer and wildlife habitat.	0.77	3.61 (1.17)
Attitudes (*ATTITUDE*): Cronbach Alpha (α) = 0.87		

e3manage: I am satisfied with the overall characteristics of forest, rangeland, and deer habitat that I maintain.	0.68	3.64 (0.95)
e3effort: I am satisfied with the number of deer and wildlife that I observed with the management effort that I put in my property.	0.85	3.71 (1.07)
e3wilder: I am satisfied with the wilderness of forest, rangeland, and deer habitat that I maintain.	0.88	3.63 (1.02)
e3overall: I am satisfied with the overall benefits I am getting from forest, rangeland, and deer habitat that I manage.	0.78	3.57 (1.04)

Intentions (*INTENT*): Cronbach Alpha (α) = 0.38

a7wtp: Assume that you do not observe any deer in your regular hunting site. How many dollars/acres are you willing to spend to maintain the deer population you generally observe in that site to receive desired hunting experience? (USD)	0.43	63.56 (109.43)

a9altdist: If you could not go to the site that you regularly hunt deer, how far would you drive one way to go to another deer hunting site of about the same quality? (miles)	0.24	35.04 (93.58)
c6interest: Are you interested in knowing more about active forest or rangeland management in Oklahoma?	0.61	0.61 (0.50)

At least 60% of landowners agreed or strongly agreed (henceforth, agree) towards variables related to subjective norms, perceived behavior control, and moral norms. An exception is that only about 51% and 33% of landowners agreed and remained neutral respectively to the statement that they should actively manage their property to maintain habitat for deer and wildlife (*e2maintain*). Despite a relatively smaller portion of landowners feeling that they should actively manage their lands, about 73% of landowners agreed that they have resources and opportunities to actively manage their land (*e1resource*). About 85% of landowners also agreed that sustainable management of forest and rangeland is important to people they value most (*e1value*). About 66% of landowners agreed that their family and friends are supportive of sustainable management of forest, rangeland, and deer habitat management activities (*e1support*) and about 75% of landowners agreed that their family and friends think that active management could enhance biodiversity (*e1diverse*). About 72% landowners also agreed that their family and friends think that management of forest and rangeland would make our environment more livable (*e1livable*). About 68% landowners feel honored to invest money, time, and resources to actively manage their land for wildlife and deer habitat management (*e2invest*). Like previous statement, about 67% of landowners agreed that they give respect to people involved in active management of ecosystem (*e2respect*).

The satisfaction level from management, however, was relatively low for landowners given the level of management effort they input. Though about 61% of landowners were satisfied with the overall characteristics of their forest, rangeland, and deer habitat they manage on their property (*e3manage*), only about 40% of landowners were satisfied with the number of deer and wildlife they observed with the management

effort they put in their property (*e3effort*). Only about 42% of landowners were satisfied with the wilderness they maintain (*e3wilder*) and about 37% remained neutral on the statement. Similarly, only about 23% of landowners agreed and about 31% remained neutral with the statement that they were satisfied with the overall benefits they are receiving from the land they manage (*e3overall*). About 64 % of landowners, nevertheless, agreed that they can improve forest, rangeland, and deer habitat by actively managing them (*e1improve*). The detailed summary of the results is presented in Table 2. The variables that are not included in the SEM models but asked in the survey were presented in Appendix A as supplementary material.

Table 2: Distribution of landowners' responses to observed variables used in SEM models.

Variables	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	N
e1value	1.90	0.95	11.64	44.42	41.09	421
e1diverse	5.21	4.27	15.88	34.60	40.05	422
e1support	5.23	4.51	24.70	36.58	28.98	421
e1livable	4.05	5.24	19.05	43.10	28.57	420
e1resource	2.87	4.78	18.66	45.69	27.99	418
e1improve	3.84	5.76	26.38	38.85	25.18	417
e2respect	3.11	4.78	24.64	43.54	23.92	418
e2maintain	6.21	10.26	32.70	29.36	21.48	419
e2invest	2.63	10.05	19.38	47.13	20.81	418
e3manage	3.83	6.94	27.99	45.45	15.79	418
e3effort	19.48	15.68	28.03	23.28	13.54	421
e3wilder	7.19	13.91	36.69	29.50	12.71	417
e3overall	27.01	18.96	30.81	18.48	4.74	422

Notes: the variables are defined in table 1.

3.3 Model Results

The model fit statistics exhibited good fit for the four models representing TRA, TRA-moral, TPB, and TPB-moral (Table 3). SEM model results to test TRA, TRA-moral, TPB, TPB-moral are presented in Figures 3(a), 3(b), 4(a), and 4(b) respectively. Models were presented in the figures using structural variables only; measurement variables were excluded in the figures to simplify presentation.

Table 3: SEM Model fit statistics for all four models along with the sample size used in each model.

Fit Indicators/Models	TRA	TRA-moral	TPB	TPB-moral
Sample Size (N)	177	177	177	177
Root mean Squared Error of Approximation (RMSEA)	0.01	0.03	0.04	0.04
90% CI, Lower Bound	0.00	0.00	0.00	0.02
Upper Bound	0.05	0.06	0.06	0.06
Comparative fit index (CFI)	1.00	0.99	0.99	0.98
Standardized root mean squared residuals (SRMR)	0.04	0.04	0.05	0.05
Coefficient of determination (CD)	0.99	0.99	0.99	1.00
Akaike's information criterion (AIC)	4908.25	6081.00	5892.968	7054.78

Model summary statistics for TRA and TRA-moral are given in Table 4. In the TRA model (Figure (3a)), the subjective norm ($\beta = 0.31, p < 0.001$) significantly affected intentions for active management of forest, rangeland, and deer habitat management for deer hunting (henceforth, intentions) supporting H_1. However, attitude ($\beta = -0.20, p < 0.05$) significantly affected intentions but showed a negative correlation in the TRA model thus partially supporting H_2. In the TRA-moral model (Figure (3b)), subjective norms ($\beta = 0.02, p = 0.10$) did not directly affect intentions, rejecting H_1 but indirectly affected intentions through moral norms. Subjective norms ($\beta = 0.53, p < 0.001$) significantly affected moral norms, and moral norms ($\beta = 0.49, p < 0.001$) significantly affected intentions and were positively correlated, thus supporting H_5 and H_7 respectively. Attitude significantly affected ($\beta = -0.21, \ p < 0.05$) intentions but was negatively correlated thus, partially supporting H_2. Attitude did not significantly affect moral norms, thus rejecting H_3.

In the TPB model (Figure (4a)), subjective norms ($\beta = 0.21, p > 0.10$) and perceived behavior control ($\beta = 0.24, p > 0.10$) did not affect intentions, thus not supporting H_1 and H_4. Attitude ($\beta = -0.27, p < 0.05$), like previous models, significantly affected intentions and having a negative correlation, thus, partially supporting H_2. In TPB-moral (Figure (4b)), subjective norm ($\beta = 0.02, p > 0.10$) did not directly affect intentions again failing to support H_1. Subjective norms, however, indirectly affected intentions through moral norms, like the TRA-moral model. Subjective norms ($\beta = 0.36, p < 0.001$) significantly affected moral norms and moral norms ($\beta = 0.50, p < 0.001$) significantly affected intentions with positive correlation, again supporting H_5 and H_7 respectively. Attitude again directly affected ($\beta = -0.21, \ p < 0.05$) intentions and retained a negative

correlation, but did not affect moral norms; thus, H_2 was partially supported and H_3 was not supported. Model summary statistics for TPB and TPB-moral are also given in Table 4.

Table 4: Model summary of four SEM models (TRA, TRA-moral, TPB, and TPB-moral).

Structural/Latent Variables	TRA		TRA-moral		TPB		TPB-moral	
	β- Coef. (Std. Err.)	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**
SUBNORM ➔ *INTENT*	0.31*** (0.09)	3.41	0.02 (0.10)	0.17	0.21 (0.13)	1.64	0.02 (0.11)	0.21
ATTITUDE ➔ *INTENT*	-0.20** 0.10	-1.96	-0.21** (0.09)	-2.28	-0.27 ** (0.13)	-2.04	-0.21 ** (0.10)	-2.03
MORAL ➔ *INTENT*	-	-	0.49*** (0.17)	2.86	-	-	0.50 ** (0.19)	2.55
PBC ➔ *INTENT*	-	-	-	-	0.24 (0.24)	0.96	-0.01 (0.21)	-0.02
SUBNORM ➔ *MORAL*	-	-	0.53*** (0.72)	7.31	-	-	0.36*** (0.09)	4.03
ATTITUDE ➔ *MORAL*	-	-	0.08 (0.06)	1.33	-	-	-	-
PBC ➔ *MORAL*	-	-	-	-	-	-	0.38 ** (0.15)	2.57

Note: β-Coef. = βeta coefficients are correlation coefficients, Std. Err. = standard error of βeta coefficients. *SUBNORM* ➔ *INTENT*: subjective norms (*SUBNORM*) impact Intentions (*INTENT*) and so on. All arrows in the table are in accordance with arrows in respective models. Dashes (-) indicate irrelevant variable in the model. *** = $p < 0.001$, ** = $p < 0.05$ and * = $p < 0.10$

Unlike stated hypotheses, attitude consistently showed a negative sign in all four models. However, the pairwise correlation coefficients among subjective norms and attitudes are positive and significant in all four models. Also, subjective norms and perceived behavior control, and subjective norms and attitudes were also positive and significant in TPB and TPB-moral models (Table 5).

Table 5: Standardized correlation coefficients of latent variables in four SEM models (TRA, TRA-moral, TPB, and TPB-moral)

Components of Theories	TRA		TRA-moral		TPB		TPB-moral	
	Cor. Coef. (Std. Er.)	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**
*SUBNORM*ATTITUDE*	0.35 *** (0.07)	4.76	0.35 *** (0.07)	4.77	0.35 *** (0.07)	4.75	0.35 *** (0.07)	4.75
*SUBNORM*PBC*	-	-	-	-	0.71 *** (0.08)	8.73	0.70 *** (0.08)	8.87
*PBC*ATTITUDE*	-	-	-	-	0.52 *** (0.10)	5.04	0.48 **** (0.09)	5.21

Note: *SUBNORM*ATTITUDE*: Bivariate correlation between subjective norms (*SUBNORM*) and attitudes (*ATTITUDE*). Dashes (-) indicate irrelevant relationship in the model. *** = $p < 0.001$, ** = $p < 0.05$ and * = $p < 0.10$.

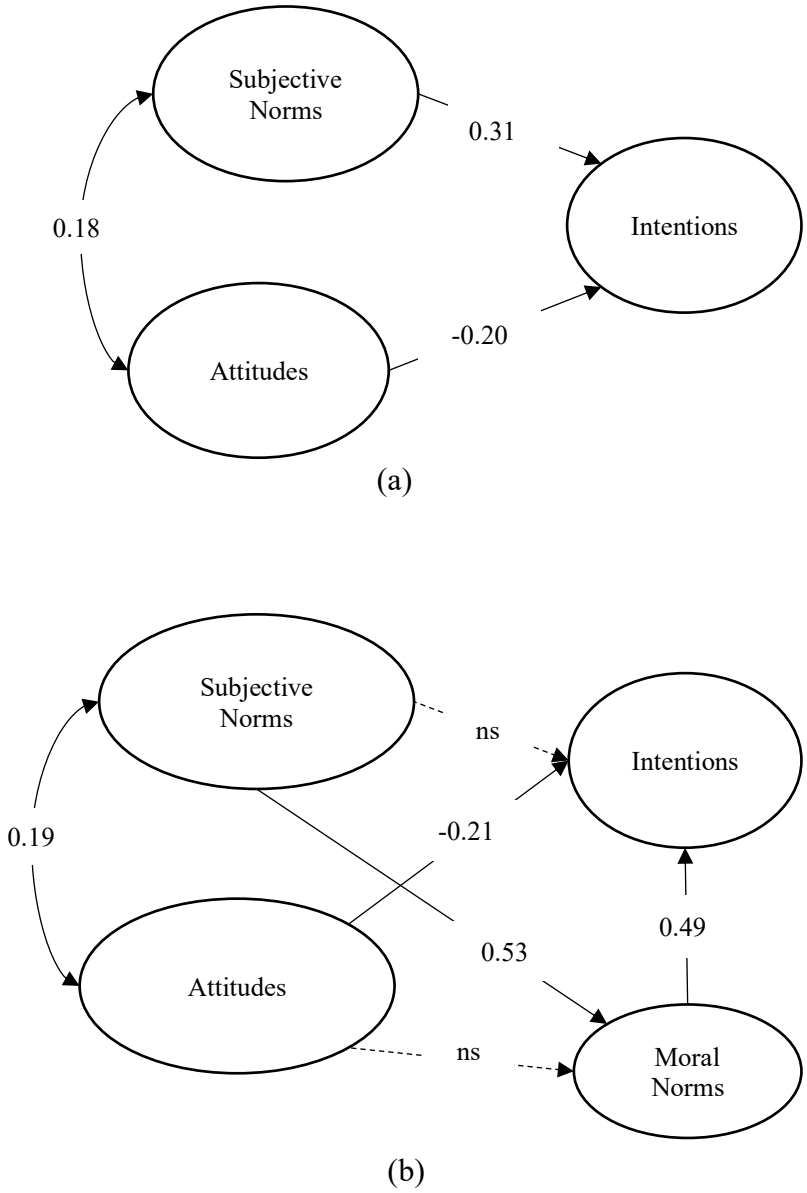
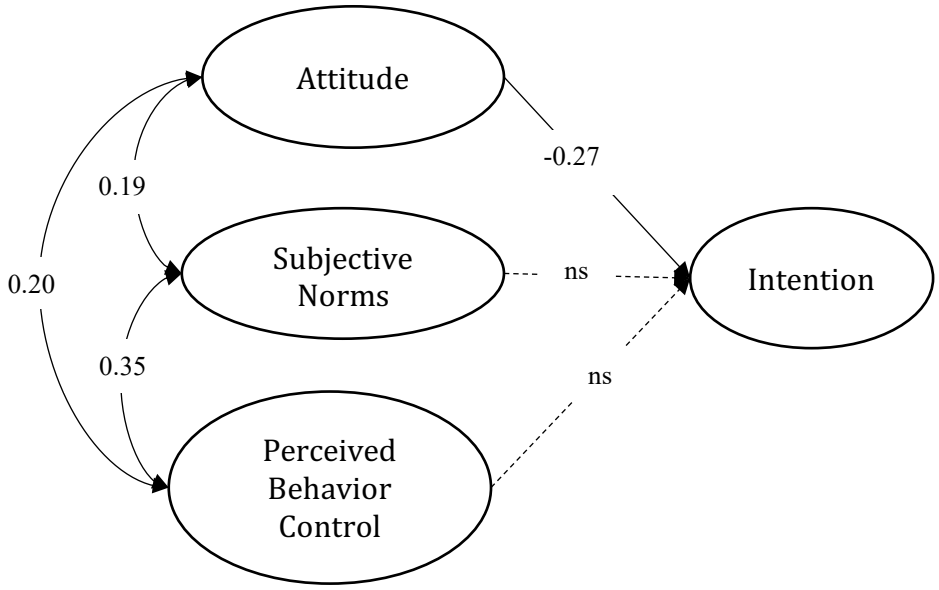
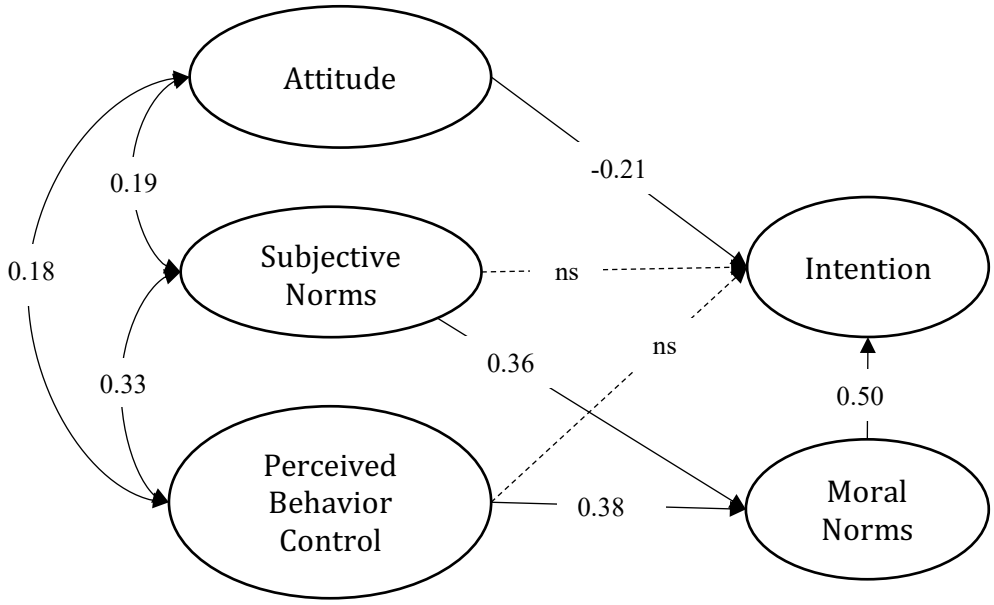


Figure 3: (a) Theory of Reasoned Action (TRA) and (b) Theory of Reasoned Action with Moral Norms (TRA-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" relationships, respectively.



(a)



(b)

Figure 4: (a) Theory of Planned Behavior (TPB) and (b) Theory of Planned Behavior with Moral Norms (TPB-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" respectively.

4. Discussion

Previous research indicated that Oklahoma landowners were supportive of using active management tools such as prescribed burning (Elmore et al., 2010) but concerned about the fire liabilities (Elmore et al., 2010; Kaur et al., 2020; Starr et al., 2019) and associated financial risk (Kaur et al., 2020; Starr et al., 2019). Fire suppression and exclusion since the mid 1900's has reduced grasslands, savannas, and open woodlands and increased closed-canopy forests (Hoff et al., 2018a; Joshi et al., 2019b). Thus, active management is needed to restore the full suite of ecosystem services along the south-central ecotone. In this context, our research studied how landowners' attitude, perceived behavior control, moral norms, and subjective norms influence active management on forest and rangeland to improve deer habitat deer hunting revenue.

Our results show that landowners have positive social pressure (subjective norms) and positive perception regarding their ability (perceived behavior control) to actively manage their land. Landowners in the study region also expressed strong positive moral support towards people and activities related to active management of forest, rangeland, and deer habitat management. Attitudes, however, have negative impacts towards active management. Attitude is the reflection of the behavioral belief that is originated from an individual's experience of performing an action (Ajzen, 2002). Despite having positive attitude, the negative relationship of attitude in the model might be from past unpleasant experience related to active management. Several researchers suggested financial burden (Kaur et al., 2020; Starr et al., 2019) and fire liabilities (Elmore et al., 2010; Joshi et al., 2019a; Starr et al., 2019) as major demotivating factors for landowners to actively manage their forested land.

The pairwise correlations among subjective norms, perceived behavior control and attitude were positively correlated signifying that the landowners with the positive subjective norms and perceived behavior control tend to have positive attitude towards active management. Active management tools such as prescribed fire has high support, but associated risk and liability issues should be addressed (Elmore et al., 2010). Similarly, financial burden associated with the active management is one of the major barriers for the active management in this ecoregion (Starr et al., 2019). Addressing associated risk and liabilities issues as well as financial burden could change the attitude of landowners and thus positively affecting the intentions for the active management.

Among four different models developed and discussed, TRA was best supported by our data, as reflected by AIC value, to explain the intentions for active management of forest, rangeland, and deer habitat management for deer hunting. The behavior, managing land for deer hunting, is under the volitional control of our study population, who are landowners owning at least 160 acres of land, which is why the behavior is better explained by TRA (Madden et al., 1992).

Perceived behavior control and intentions in SEM models have lower Cronbach alpha values. However low Cronbach alpha values are not uncommon in SEM models. Lopez-Mosquera and Sanchez (2012) also reported lower than suggested Cronbach alpha value for perceived behavior control and intentions. Latent constructs often have lower Cronbach alpha coefficients because of random error, even with meticulously planned variables (Ajzen, 2011).

5. Management Implications and Conclusion

This paper sheds light on role of attitude, perceived behavior control, and social and subjective norms on shaping intentions of landowners towards active management of forest, rangeland, and deer habitat in south-central ecotone of the USA. Exclusion of fire in this region has increased closed canopy forest and recruitment of fire susceptible species such as ERC. Meanwhile, the declining recruitment and retention and of deer hunters has raised concerns regarding the future of hunting (Peterson, 2004) and the associated tradition, cultural (Byrd et al., 2017), economic, and wildlife management strategies (Byrd et al., 2017; Peterson, 2004). This creates an opportunity to actively manage land to maintain deer habitat as a source of revenue as well as restore ecosystem services. Our research suggest that landowners are positive about actively managing their land and have positive pressure from family and friends. Landowners also show respect to stakeholders involved in active management of ecosystems and feel respectful towards those who actively manage their land. Landowners, however, are not satisfied with the management outcomes, ecosystem services, and benefits they received from their land, thus, providing an opportunity to improve ecosystem services by actively manage their land. Landowners are supportive of actively managing their land for deer hunting by maintaining a good deer habitat; motivating landowners towards stewardship of natural resources and respect towards stakeholders involved in active management motivates them to actively manage their land.

Fire related risk and liabilities can be offset by adopting prescribed burning and application of alternative management techniques such as overstory and understory thinning, herbicide application, and brush management. The perceived risk and liabilities of fire decrease with the increase in knowledge and experience associated with prescribed

burning (Joshi et al., 2019a), suggesting a need for outreach activities among landowners to increase awareness about prescribed fire.

The management cost associated with the active management can be in part be offset through hunting leases; improved deer habitat through active management could motivates deer hunters to pay more money per acres as lease fee. Based on our research we suggest extension specialists and policy makers to focus on educating landowners to make them aware about the cost and benefit associated with the active management. This will give more confidence to landowners in adoption of active management tools and helps landowners realize financial benefits which can outweigh associated cost. The realization of reduced risk and added financial benefits could motivate landowners to adopt management tools in their forest and rangeland.

6. Future Research Consideration

This paper studied landowners' attitudes, perceptions, social and peer pressure related to active management of ecosystem using SEM and broadened the scope of wildlife management research through the inclusion of moral norms in TRA and TPB models. This dimension of wildlife management research further can be expanded to other game species. Furthermore, the use of TPB and TRA for other species, and expansion of these theories using moral norms in the hunting research are yet to be understood fully. Also, TBP is criticized for ignoring human emotions, identity, and moral values (Miller, 2017) which is addressed by this paper by expanding theories by adding moral norms as suggested by (Ajzen, 1991). The recent development of theory of planned behavior is more suggestive towards mediating role of perceived behavior control between attitude-

intention and subjective norms-attitude and inclusion of sociodemographic variables into the model (Ajzen, 2020; Sok et al., 2020) which is out of scope of this paper but something to consider for future research.

Acknowledgement

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Reference

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Process 50, 179-211.

Ajzen, I., 2002. Perceived behavioral control, self-efficacy, locus of control and the theory of planned behavior. Journal of Applied Social Psychology 32, 665-683.

Ajzen, I., 2011. The theory of planned behaviour: reactions and reflections. Psychol Health 26, 1113-1127.

Ajzen, I., 2020. The theory of planned behavior: Frequently asked questions. Human Behavior and Emerging Technologies 2, 314-324.

Anderson, J.C., David, W., Grebing, 1988. Structural Equation modeling in practice: A review and recommended two-step approach. Psychological Bulletin 103, 411-423.

Byrd, E., Lee, J.G., Widmar, N.J.O., 2017. Perceptions of Hunting and Hunters by U.S. Respondents. Animals (Basel) 7.

Caputo, J., Butler, B., 2021. National Woodland Owner Survey Dashboard (NWOS-DSH) Verson 1.0. USDA Forest Service, Forest Inventory and Analysis.

Clark, S.L., Hallgren, S.W., Engle, D.M., Stahle, D., 2007. The historic fire regime on the edge of the prairie: a case study from the cross timbers of Oklahoma, in: Masters, R.E., Galley,

K.E.M. (Eds.), 23rd Tall Timbers Fire Ecology Conference: Fire in Grassland and Shrubland Ecosystems, Tall Timbers Research Station, Tallahassee, Florida, USA., pp. 40-49.

Coon, J.J., van Riper, C.J., Morton, L.W., Miller, J.R., 2020. What drives private landowner decisions? Exploring non-native grass management in the eastern Great Plains. J Environ Manage 276, 111355.

Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. Psychometrika 16, 297-334.

Daigle, J.J., Hrubes, D., Ajzen, I., 2010. A Comparative Study of Beliefs, Attitudes, and Values Among Hunters, Wildlife Viewers, and Other Outdoor Recreationists. Human Dimensions of Wildlife 7, 1-19.

Demarais, S., 1992. The Pristine Myth: The lLandscape of the Americas in 1492. Annals of the Association of American Geographers 82, 369-385.

Dillman, D.A., Smyth, J.D., Christian, L.M., 2014. Internet, phone, mail, and mixed-mode surveys: The tailored design method. John Wiley & Sons, Inc., Hoboken, New Jersey.

Elmore, R.D., Bidwell, T.G., Weir, J.R., 2010. Perceptions of oklahoma residents to prescribed fire, in: Robertson, K.M., Galley, K.E.M., Masters, R.E. (Eds.), 24th Tall Timbers Fire Ecology Conference: The Future of Prescribed Fire: Public Awareness, Health, and Safety. Tall Timbers Research Station, Tallahassee, Florida, USA, Tall Timbers Research Station, Tallahassee, Florida, USA, pp. 55-66.

Fishbein, M., Ajzen, I., 1975. Belief, attitude, intention and behavior: an introduction to theory and research. Addison-Wesley Publishing Company, Philippines.

Füssel, H.-M., 2007. Vulnerability: A generally applicable conceptual framework for climate change research. Global Environmental Change 17, 155-167.

Gunzler, D.D., Morris, N., 2015. A tutorial on structural equation modeling for analysis of overlapping symptoms in co-occurring conditions using MPlus. Stat Med 34, 3246-3280.

Hallgren, S.W., DeSantis, R.D., Burton, J.A., 2012. Fire and vegetation dynamics in the cross timbers forest of south-central north america, 4th Fire in Eastern Oak Forests Conference, pp. 52-66.

Heidari, A., Kolahi, M., Behravesh, N., Ghorbanyon, M., Ehsanmansh, F., Hashemolhosini, N., Zanganeh, F., 2018. Youth and sustainable waste management: a SEM approach and extended theory of planned behavior. Journal of Material Cycles and Waste Management 20, 2041-2053.

Hoff, D., Will, R., Zou, C., Lillie, N., 2018a. Encroachment Dynamics of Juniperus virginiana L. and Mesic Hardwood Species into Cross Timbers Forests of North-Central Oklahoma, USA. Forests 9.

Hoff, D.L., Will, R.E., Zou, C.B., Weir, J.R., Gregory, M.S., Lillie, N.D., 2018b. Estimating increased fuel loading within the Cross Timbers forest matrix of Oklahoma, USA due to an encroaching conifer, Juniperus virginiana, using leaf-off satellite imagery. Forest Ecology and Management 409, 215-224.

Hrubes, D., Ajzen, I., Daigle, J., 2001. Predicting Hunting Intentions and Behavior: An Application of the Theory of Planned Behavior. Leisure Sciences 23, 165-178.

Jones, P.D., Mixon, M.R., Demarais, S., 2009. Habitat Quality Following Mid-Rotation Treatment in Conservation Reserve Program Pines. Journal of Wildlife Management 73, 1166-1173.

Joshi, O., Poudyal, N.C., Weir, J.R., Fuhlendorf, S.D., Ochuodho, T.O., 2019a. Determinants of perceived risk and liability concerns associated with prescribed burning in the United States. J Environ Manage 230, 379-385.

Joshi, O., Will, R.E., Zou, C.B., Kharel, G., 2019b. Sustaining Cross-Timbers Forest Resources: Current Knowledge and Future Research Needs. Sustainability 11.

Kaur, R., Joshi, O., Will, R.E., 2020. The ecological and economic determinants of eastern redcedar (Juniperus virginiana) encroachment in grassland and forested ecosystems: A case study from Oklahoma. J Environ Manage 254, 109815.

Leslie Jr., D.M., Soper, R.B., Lochmiller, R.L., Engle, D.M., 1996. Habitat use by white-tailed deer on cross timbers rabngeland following brush management. Journal of Rangeland Management 49, 401-406.

Lopez-Mosquera, N., Garcia, T., Barrena, R., 2014. An extension of the Theory of Planned Behavior to predict willingness to pay for the conservation of an urban park. J Environ Manage 135, 91-99.

Lopez-Mosquera, N., Sanchez, M., 2012. Theory of Planned Behavior and the Value-Belief-Norm Theory explaining willingness to pay for a suburban park. J Environ Manage 113, 251-262.

Lovell, W.G., Dobyns, H.F., Denevan, W.M., Woods, W.I., Mann, C.C., 2004. 1491: In search of native america. Journal of the Southwest 46, 441-461.

Madden, T.J., Ellen, P.S., Ajzen, I., 1992. A comparison of the Theory of planned behavior and the theory of reasoned action. Personal and Social Psychology Bulletin 18, 3-9.

Mann, C.C., 2002. 1491, The Atlantic. The Atlantic Monthly Group, Boston.

Miller, Z.D., 2017. The Enduring Use of the Theory of Planned Behavior. Human Dimensions of Wildlife 22, 583-590.

Peterson, M.N., 2004. An approach for demonstrating the social legitimacy of hunting. Wildlife Society Bulletin 32, 310-321.

Poudyal, N.C., Watkins, C., Joshi, O., 2020. Economic contribution of wildlife management areas to local and state economies. Human Dimensions of Wildlife 25, 291-295.

Riddle, A.A., 2019. Timber harvesting on Federal lands. Congresional Research Service.

Rossi, A.N., Armstrong, J.B., 1999. Theory of reasoned action vs. theory of planned behavior: Testing the suitability and sufficiency of a popular behavior model using hunting intentions. Human Dimensions of Wildlife 4, 40-56.

Schreiber, J.B., 2017. Update to core reporting practices in structural equation modeling. Res Social Adm Pharm 13, 634-643.

Sok, J., Borges, J.R., Schmidt, P., Ajzen, I., 2020. Farmer Behaviour as Reasoned Action: A Critical Review of Research with the Theory of Planned Behaviour. Journal of Agricultural Economics 72, 388-412.

Starr, M., Joshi, O., Will, R.E., Zou, C.B., 2019. Perceptions regarding active management of the Cross-timbers forest resources of Oklahoma, Texas, and Kansas: A SWOT-ANP analysis. Land Use Policy 81, 523-530.

StataCorp, 2017. STATA structure equation modeling reference manual, Release 15 ed. Stata Press, College Station, TX: StataCorp LLC.

Urbano, J., Lima, H., Hanjalic, A., 2019. A New Perspective on Score Standardization, Proceedings of the 42nd International ACM SIGIR Conference on Research and Development in Information Retrieval, Paris, France, pp. 1061-1064.

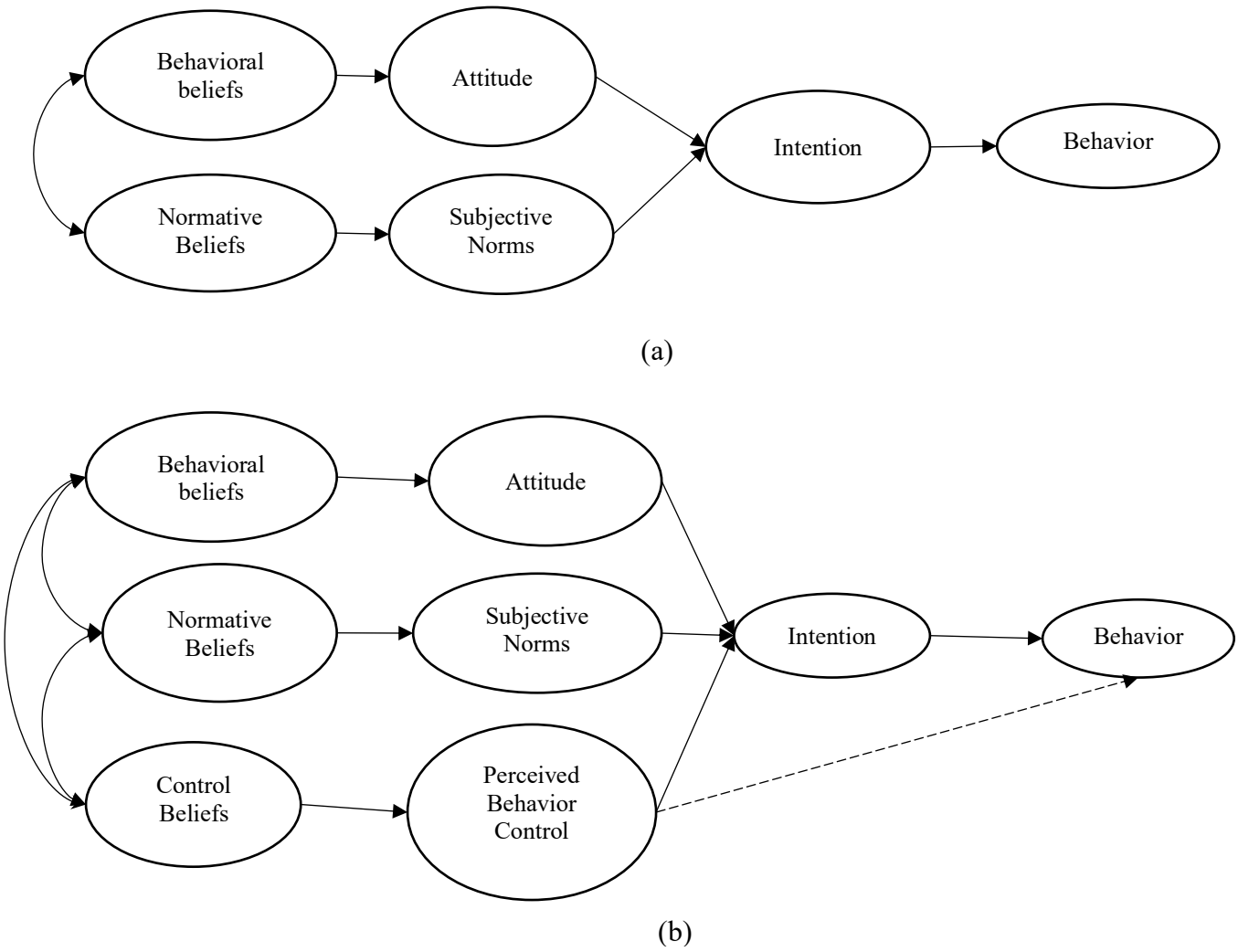


Figure 1: (a) Theory of Reasoned Action and (b) Theory of Planned Behavior.

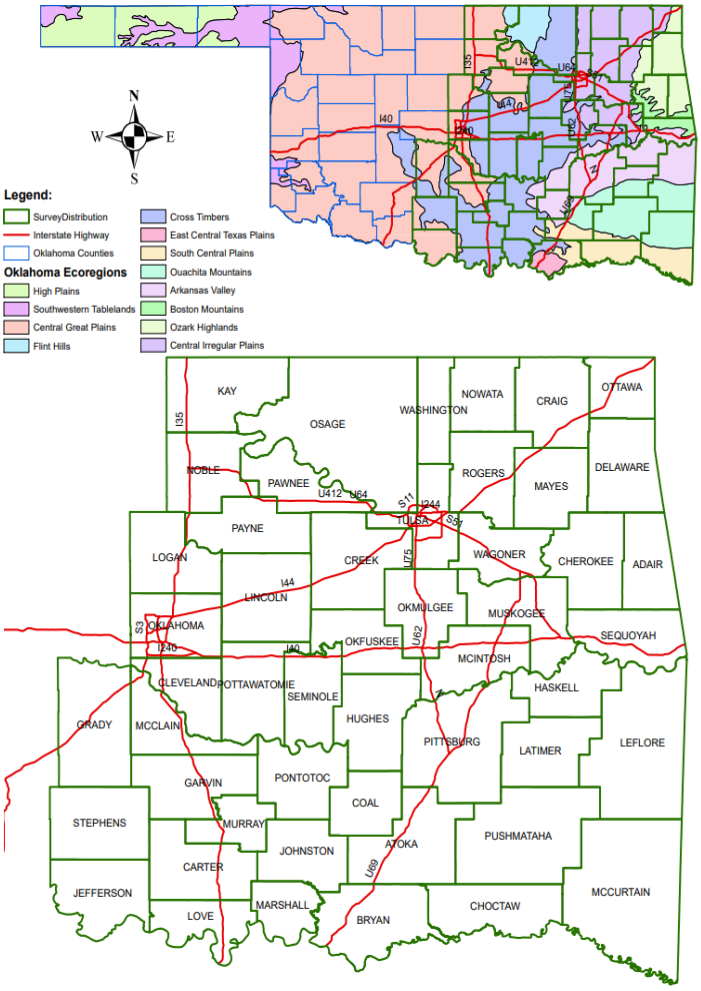


Figure 2: Study region: map of Oklahoma representing various ecoregions (top) and counties receiving surveys (bottom).

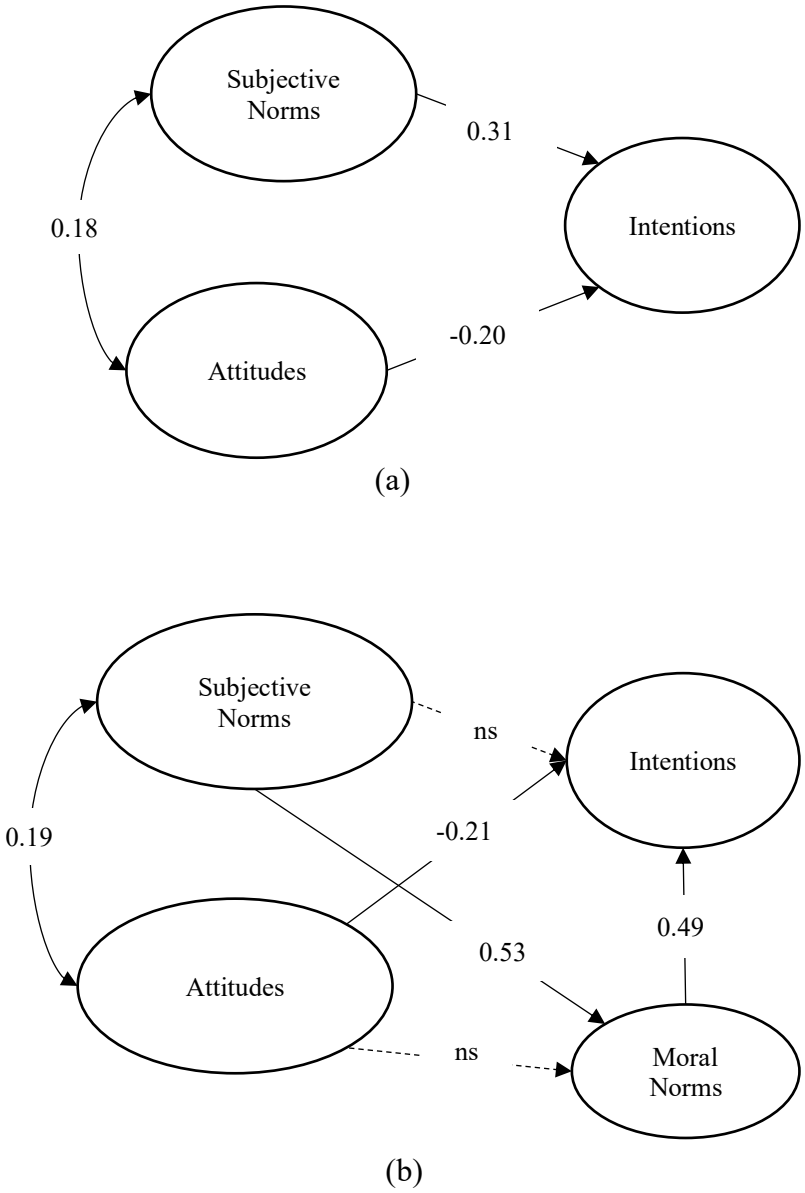
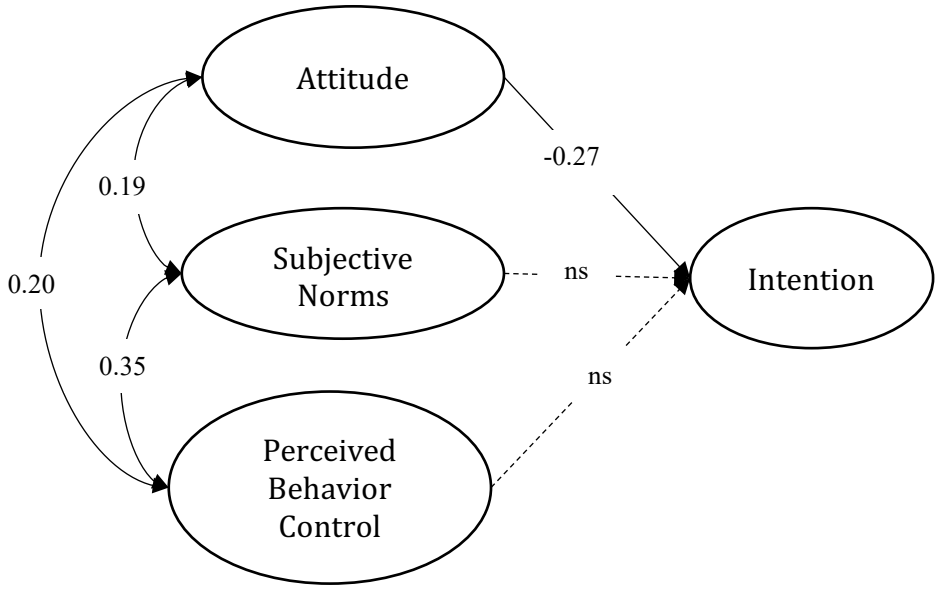


Figure 3: (a) Theory of Reasoned Action (TRA) and (b) Theory of Reasoned Action with Moral Norms (TRA-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" relationships, respectively.



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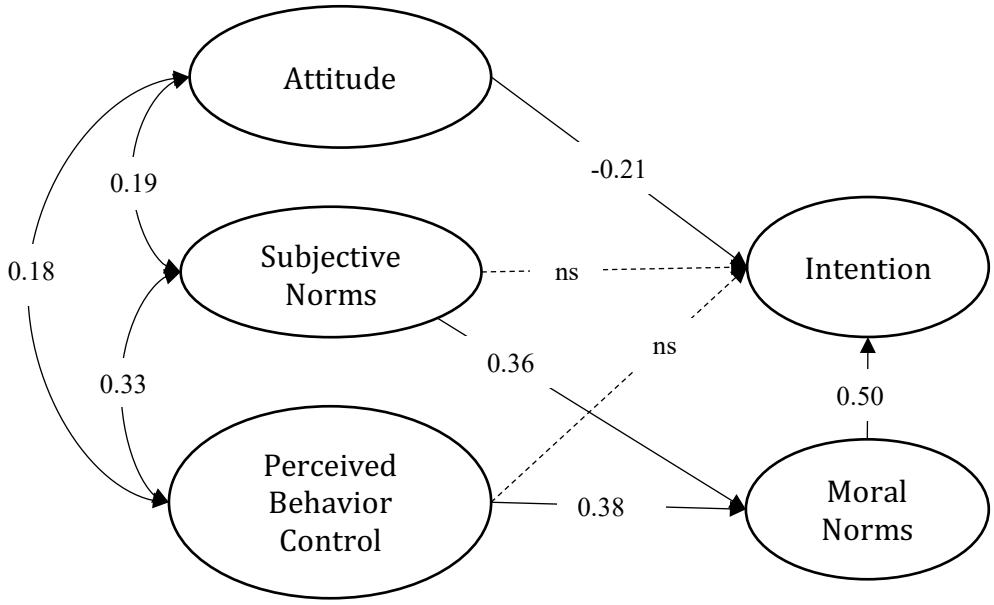

(b)

Figure 4: (a) Theory of Planned Behavior (TPB) and (b) Theory of Planned Behavior with Moral Norms (TPB-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" respectively.

Table 1: Validity of structural variables, descriptions, and descriptive statistics of measurement variables.

Measurement Variables in SEM Models	**Factor Loading (λ) (N = 177)**	**Mean (St. Dev.) (N = 177)**
Subjective Norms (*SUBNORM*): Cronbach Alpha (α) = 0.89		
e1value: Sustainable management of forest, rangeland and deer habitat is important to the people I value most.	0.77	3.81 (1.08)
e1diverse: My family and friends think that forest, rangeland, and deer habitat management could enhance plant and animal diversity.	0.83	3.61 (1.13)
e1support: My family and friends are supportive of forest, rangeland, and deer habitat management activities.	0.91	3.83 (1.04)
e1livable: My family and friends think that forest, rangeland, and deer habitat management would make our environment more livable.	0.81	3.57 (1.12)

Perceived Behavior Controls (*PBC*): Cronbach Alpha (α) = 0.52		
e1resource: I have resource and opportunities to manage my land for forest, rangeland, and deer habitat management.	0.46	3.49 (1.17)
e1improve: I think that I can improve forest, rangeland, and deer habitat on my property by actively managing them.	0.72	3.96 (0.99)
Moral Norms (*MORAL*): Cronbach Alpha (α) = 0.82		
e2respect: I give respect and courtesy to people who are involved in forest, rangeland, and deer habitat management.	0.68	4.25 (0.85)
e2maintain: I feel that I should actively manage forest, rangeland, and deer habitat on my property to maintain deer habitat for deer and wildlife.	0.92	3.97 (0.99)
e2invest: I feel honored to invest money, time, and resources to manage forest, rangeland and deer habitat for deer and wildlife habitat.	0.77	3.61 (1.17)
Attitudes (*ATTITUDE*): Cronbach Alpha (α) = 0.87		

e3manage: I am satisfied with the overall characteristics of forest, rangeland, and deer habitat that I maintain.	0.68	3.64 (0.95)
e3effort: I am satisfied with the number of deer and wildlife that I observed with the management effort that I put in my property.	0.85	3.71 (1.07)
e3wilder: I am satisfied with the wilderness of forest, rangeland, and deer habitat that I maintain.	0.88	3.63 (1.02)
e3overall: I am satisfied with the overall benefits I am getting from forest, rangeland, and deer habitat that I manage.	0.78	3.57 (1.04)

Intentions (*INTENT*): Cronbach Alpha (α) = 0.38

a7wtp: Assume that you do not observe any deer in your regular hunting site. How many dollars/acres are you willing to spend to maintain the deer population you generally observe in that site to receive desired hunting experience? (USD)	0.43	63.56 (109.43)

a9altdist: If you could not go to the site that you regularly hunt deer, how far would you drive one way to go to another deer hunting site of about the same quality? (miles)	0.24	35.04 (93.58)
c6interest: Are you interested in knowing more about active forest or rangeland management in Oklahoma?	0.61	0.61 (0.50)

Table 2: Distribution of landowners' responses to observed variables used in SEM models.

Variables	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	N
e1value	1.90	0.95	11.64	44.42	41.09	421
e1diverse	5.21	4.27	15.88	34.60	40.05	422
e1support	5.23	4.51	24.70	36.58	28.98	421
e1livable	4.05	5.24	19.05	43.10	28.57	420
e1resource	2.87	4.78	18.66	45.69	27.99	418
e1improve	3.84	5.76	26.38	38.85	25.18	417
e2respect	3.11	4.78	24.64	43.54	23.92	418
e2maintain	6.21	10.26	32.70	29.36	21.48	419
e2invest	2.63	10.05	19.38	47.13	20.81	418
e3manage	3.83	6.94	27.99	45.45	15.79	418
e3effort	19.48	15.68	28.03	23.28	13.54	421
e3wilder	7.19	13.91	36.69	29.50	12.71	417
e3overall	27.01	18.96	30.81	18.48	4.74	422

Notes: the variables are defined in table 1.

Table 3: SEM Model fit statistics for all four models along with the sample size used in each model.

Fit Indicators/Models	TRA	TRA-moral	TPB	TPB-moral
Sample Size (N)	177	177	177	177
Root mean Squared Error of Approximation (RMSEA)	0.01	0.03	0.04	0.04
90% CI, Lower Bound	0.00	0.00	0.00	0.02
Upper Bound	0.05	0.06	0.06	0.06
Comparative fit index (CFI)	1.00	0.99	0.99	0.98
Standardized root mean squared residuals (SRMR)	0.04	0.04	0.05	0.05
Coefficient of determination (CD)	0.99	0.99	0.99	1.00
Akaike's information criterion (AIC)	4908.25	6081.00	5892.968	7054.78

Table 4: Model summary of four SEM models (TRA, TRA-moral, TPB, and TPB-moral).

Structural/Latent Variables	TRA		TRA-moral		TPB		TPB-moral	
	β- Coef. (Std. Err.)	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**	**β- Coef. (Std. Err.)**	**Z-Statistics**
SUBNORM ➔ *INTENT*	0.31*** (0.09)	3.41	0.02 (0.10)	0.17	0.21 (0.13)	1.64	0.02 (0.11)	0.21
ATTITUDE ➔ *INTENT*	-0.20** 0.10	-1.96	-0.21** (0.09)	-2.28	-0.27 ** (0.13)	-2.04	-0.21 ** (0.10)	-2.03
MORAL ➔ *INTENT*	-	-	0.49*** (0.17)	2.86	-	-	0.50 ** (0.19)	2.55
PBC ➔ *INTENT*	-	-	-	-	0.24 (0.24)	0.96	-0.01 (0.21)	-0.02
SUBNORM ➔ *MORAL*	-	-	0.53*** (0.72)	7.31	-	-	0.36*** (0.09)	4.03
ATTITUDE ➔ *MORAL*	-	-	0.08 (0.06)	1.33	-	-	-	-
PBC ➔ *MORAL*	-	-	-	-	-	-	0.38 ** (0.15)	2.57

Note: β-Coef. = βeta coefficients are correlation coefficients, Std. Err. = standard error of βeta coefficients. *SUBNORM* ➔ *INTENT*: subjective norms (*SUBNORM*) impact Intentions (*INTENT*) and so on. All arrows in the table are in accordance with arrows in respective models. Dashes (-) indicate irrelevant variable in the model. *** = $p < 0.001$, ** = $p < 0.05$ and * = $p < 0.10$

Table 5: Standardized correlation coefficients of latent variables in four SEM models (TRA, TRA-moral, TPB, and TPB-moral)

Components of Theories	TRA		TRA-moral		TPB		TPB-moral	
	Cor. Coef. (Std. Er.)	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**	**Cor. Coef. (Std. Er.)**	**Z-Statistics**
*SUBNORM*ATTITUDE*	0.35 *** (0.07)	4.76	0.35 *** (0.07)	4.77	0.35 *** (0.07)	4.75	0.35 *** (0.07)	4.75
*SUBNORM*PBC*	-	-	-	-	0.71 *** (0.08)	8.73	0.70 *** (0.08)	8.87
*PBC*ATTITUDE*	-	-	-	-	0.52 *** (0.10)	5.04	0.48 **** (0.09)	5.21

Note: *SUBNORM*ATTITUDE*: Bivariate correlation between subjective norms (*SUBNORM*) and attitudes (*ATTITUDE*). Dashes (-) indicate irrelevant relationship in the model. *** = $p < 0.001$, ** = $p < 0.05$ and * = $p < 0.10$.

Intentions of Landowners Towards Active Management for White-tailed Deer Hunting in the Forest-Grassland Transitional Ecoregion of the South-Central USA

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Supplementary Materials

Appendix A

Table 1: Distribution of landowners' responses to variables presented in same section of survey but not included in SEM.

Variables	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	N
e1govt: It would be difficult to conduct forest, rangeland, and deer habitat management without government support.	4.73	3.78	22.70	41.61	27.19	423
e1commun: It would be difficult to conduct forest, rangeland, and deer habitat management without support from the community.	6.35	4.94	27.53	34.35	26.82	425
e2harvest: Excessive harvesting of natural resource may limit their use for the future generation.	4.03	7.82	24.64	39.34	24.17	422
e3benefit: Active forest, rangeland, and deer habitat can bring economic as well as environmental benefits.	7.88	10.98	33.65	27.92	19.57	419
e3human: The primary use of forest, rangeland, and deer habitat management should be to benefit human beings.	4.06	8.59	31.50	36.99	18.85	419

e3restrict: Restricting excessive use of forest, rangeland, and deer habitat can enhance recreational opportunities.	6.65	9.74	27.79	37.29	18.53	421
e3time: It is important to spend time managing forest, rangeland, and deer habitat.	2.39	9.07	25.30	45.11	18.14	419
e3balance: Sustainable management of forest, rangeland, and deer habitat is important to maintain balance and diversity in the natural environment.	9.50	14.01	27.55	31.59	17.34	421
e3connect: I feel connected with nature when I get involved in forest, rangeland, and deer habitat management.	0.96	10.29	22.73	49.52	16.51	418
e3environ: The primary use of forest, rangeland, and deer habitat management should be to benefit the environment.	6.92	16.23	29.36	31.50	15.99	419
e3noneed: There is no need for active, forest, rangeland, and der habitat management.	41.73	28.78	19.66	6.00	3.84	417

Credit Author Statement

Bijesh Mishra: Research conceptualization and advancement, Methodology, data curation, and formal analysis, write and refine manuscript.

Omkar Joshi: Research concept advancement, manuscript review and editing, supervision, advising, data curation, formal analysis, manuscript quality assurance, validation, funding acquisition, software, resource, and project administration.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: