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Title:

Intentions of Landowners ~~in South-central USA~~ towards Active Management of Ecosystem for Deer Habitat

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Abstract:

Active management such as prescribed fire and thinning can restore ~~the~~ savanna and prairie ecosystem to maintain a full suite of ecosystem services and create suitable habitat for wildlife species such as white-tailed deer (*Odocoileus virginianus*). Active management comes with the cost of management and acceptance of management tools. The south-central transitional ecoregion of the USA, which otherwise was a mixture of forest, savanna, and tallgrass prairie, is increasing in woody plant dominance due to the exclusion of fire and other anthropogenic factors ~~which otherwise was a mixture of forest, savanna, and tallgrass prairie~~. 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 have negative relations with the intentions. The study suggested that landowners have positive social pressure and were interested in 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*)

Statement and Declarations

The authors declare no financial and personal conflict of interest.

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1. *Introduction*

Active management using prescribed fire and thinning are important tools used to sustainably manage forest ecosystems by building resiliency against changing climate (Clark et al., 2007; Joshi et al., 2019a; Starr et al., 2019a). Management costs and potential liabilities from using fire have restricted its application as an active management tool (Starr et al., 2019a). Previous research suggested that well managed, healthy, and resilient forests provide an opportunity to increase revenue to landowners, which in turn increases active management (Joshi et al., 2019b; Starr et al., 2019a). Wildlife management activities, such as deer hunting, provide important economic benefits at the local and regional level in the southern USA (Poudyal et al., 2020) and serve as a vital wildlife management tool (Byrd et al., 2017; Peterson, 2004). Deer hunting can be an important motivation for landowners to actively manage ecosystems due to its large economic benefit at the local and state level (Poudyal et al., 2020) in the south-central USA.

Historically, fire was used as a tool to manage ecosystems in the south-central USA. The south-central ecoregion was a dynamic area consisting of upland forests, savanna, and tallgrass prairie lying between eastern forests and western grassland (Hallgren et al., 2012; Joshi et al., 2019b). Fire was mostly excluded after European-American settlement leading to an increase in forest cover with a greater abundance of mesophotic, fire-sensitive hardwoods species and the fire-sensitive eastern redcedar (henceforth, redcedar) (*Juniperus virginiana*) (Joshi et al., 2019b; Starr et al., 2019a). This transitional nature of the ecoregion coupled with drought and erratic rainfall (Clark et al., 2007; Hallgren et al., 2012) makes it vulnerable to climate change (Füssel, 2007). The increase in redcedar has the potential to increase wildfire risk (Hoff et al., 2018b) which further worsens the negative consequences of climate change.

Landowners are supportive of using prescribed fire to actively manage their land (Elmore et al., 2010) ~~yet,~~yet prescribed fire is not frequently used in south-central USA. Beliefs, past experiences, and social pressure play important roles in shaping attitudes and intentions (Ajzen, 2020; Madden et al., 1992) of landowners. The intention of landowners towards active management is not yet well understood in this region. Thus, this paper addresses the question of how landowners' beliefs, attitudes, norms, and intentions for the active management of forests and rangeland for deer habitat management are interrelated. Deer hunting is an important cultural tradition often transferred from generation to generation (Byrd et al., 2017; Demarais, 1992; Lovell et al., 2004; Mann, 2002)

in the US South. In addition to harvesting deer for meat (Byrd et al., 2017; Hrubes et al., 2001) deer hunting also 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.

The behavioral intentions of landowners towards active management were studied using the theory of reasoned action (TRA) and the theory of planned behavior (TPB). Both theories describe how human intentions were shaped based on their belief, norms, and past actions (Ajzen, 2020). These two theories are widely used in the ~~comparative~~ study of ~~TRA and TPB (Daigle et al., 2010; Hrubes et al., 2001; Rossi and Armstrong, 1999),~~ deer hunting (Daigle et al., 2010), willingness to pay (Lopez-Mosquera et al., 2014), and several other subjects summarized by (Ajzen, 1991, 2011). No previous studies 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 adopting active deer habitat management tools that potentially result in increased revenue from hunting. Second, this is the first scholarly effort that used TRA and TPB to analyze inter-relationships between values, norms, attitudes, and behavioral intentions in the grassland-forestland tension zone—a distinct ecoregion having a cultural significance in the United States. Third, following previous work (Lopez-Mosquera et al. 2014), we further the scope of TRA and TPB by adding moral norms into both theories as suggested by Ajzen (1991). This paper, thus, tested four models—two theories with and two without moral norms— to study intentions towards active management of forest and rangeland for deer habitat management. 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 the 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 two without moral norms—to study intentions towards active management of forest and rangeland for deer habitat management.~~

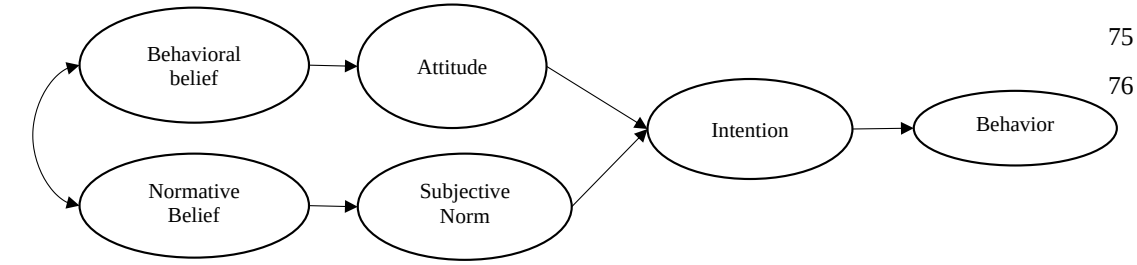
Methods

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

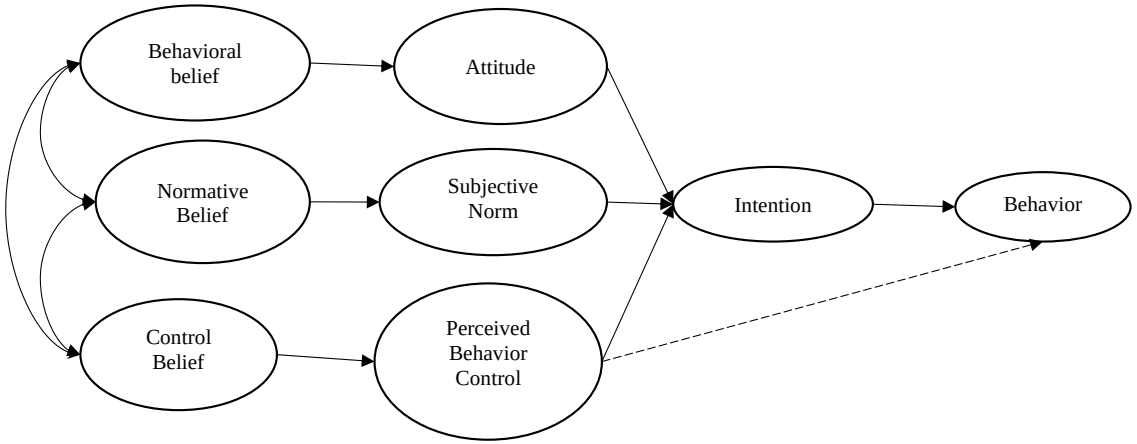
The TRA proposes that human intention is an immediate precursor to action. The action originates from a belief that performing an activity leads to the intended outcome (Madden et al., 1992), assuming the action is under

the volitional control of an individual. The theory, however, does not account for an action that the individual intends to perform but is not under their actual control (i.e., volitional control) (Ajzen, 2002). This limitation involving volitional control is addressed in TPB 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). TPB, thus, can be understood as the addition of perceived behavioral control to TRA. TPB reduces to TRA when the behavior is under volitional control (Ajzen, 2020). The theoretical models (Figure 1~~Figure 1~~) for this paper were adopted from Ajzen (1991) and Madden et al. (1992).

The TPB assumes that a belief towards an action shapes a person's attitude and norms. Attitude and norms further shape intentions toward the action. Positive beliefs, attitudes, norms, and intentions toward an action motivate 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 action. Normative beliefs originate from social standards, values, norms, and pressure which shape the 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.

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2.2 Survey Design and Administration

The mailed survey was conducted following the tailored design method suggested by Dillman et al. (2014). The study area represented the portion of the forest-grassland transition ecoregion of the south-central USA in Oklahoma (Figure 2~~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 then bulk mailed to 2,500 randomly selected Oklahoma landowners out of which, 16 were unable to participate because of missing address, deceased, refused to participate, and no longer managing land reducing total sample to 2,484.. The survey package included a personalized cover letter, questionnaire, and prepaid return envelope.

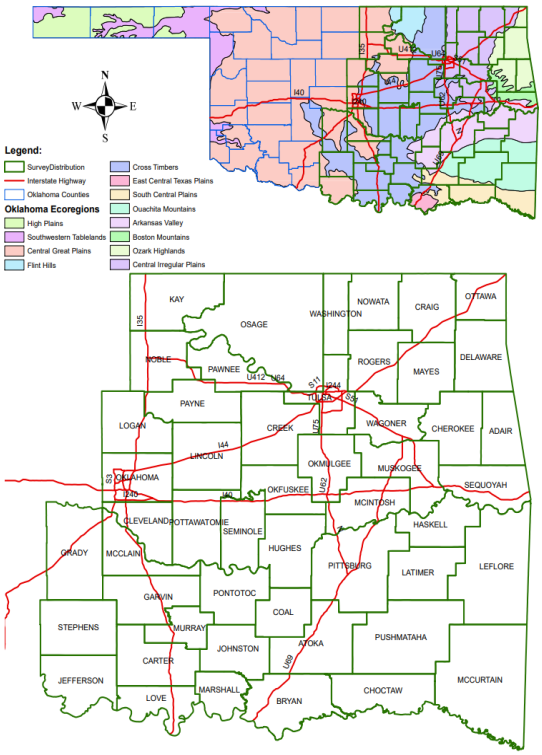

Figure 2: Study region: map of Oklahoma representing various ecoregions (top) and counties receiving surveys (bottom).

With some modifications on Dillman's Total Design Method (TDM) procedures, randomly selected landowners were each sent two rounds of surveys with a gap of about two months, each followed by reminder postcards after about a month of survey mailing (Dillman et al. 2014). The second round of surveys and postcards were mailed to landowners who did not respond during the first round of survey mailing. Total 508 responses, response rate 20.45%, were obtained after the second round of the survey. The demographics of the landowners were compared with National Woodland Owner's Survey (NWOS) results (Butler et al. 2020). Early and late response biases were conducted using chi-square tests on age, gender, income, education, and race among landowners' responses received after the first and second lots of survey and postcards.

The questions were asked on a 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 sites with similar quality, and interest (yes/no) in active management of their land. Outliers in travel distance (> 100 miles) to alternative hunting sites were excluded from the analysis. Because of the difference in measurement scale, the observed variables loaded as intentions in the model were normalized by dividing the difference between the mean and observed value for each observation by the standard deviation of the variable. 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 these were used in structural equation models (SEM). Model Fit indices, factor loadings, standard error of factor loadings, Cronbach alpha, mean and standard deviations of observed variables, and statistics from SEM models were reported after removing missing observations and outliers on a list-wise basis using a total of 165 observations.

2.3 Hypothesis

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

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

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

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

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

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

Hypothesis 6 (H_6): Positive perceived behavior control shapes 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 variable loading in the latent constructs. The model fit indicators were determined by using several models 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), Tucker Lewis Index (TLI), and coefficient of determination (CD, ≥ 0.95) (StataCorp, 2017). Akaike Information Criterion (AIC), the smaller the better, was used for model comparison (StataCorp, 2017). RMSEA estimates population errors, CFI and TLI make baseline comparisons with the null model, and SRMR and CD compare the size of residuals. CD is analogous to R^2 for the model (StataCorp, 2017).

2.4.2 Path analysis

A structural equation model (SEM) was used for the study. 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 a path from subjective norms to intentions through moral norms. Similarly, TPB-moral was developed by adding two additional paths from subjective norms and perceived behavior control intentions through moral norms. Structural equation models were fit using the "*sem*" command in STATA 15.1 provides estimation under the assumption of joint normality and fits linear SEMs using the maximum likelihood estimation method (StataCorp, 2017). The command *sem* provides Maximum likelihood estimators that have asymptotic, unbiased, consistent, and efficient properties under the normality assumption of observed variables (Anderson and David, 1988). The standard error was robust Satorra-Bentler scaled standard error (Satorra and Bentler, 1994).

Structural equation models were fit following the procedure suggested by Anderson and David (1988) after obtaining acceptable ranges 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 was used in all four models. The command *sem* assumes that observed

endogenous, observed exogenous variables, latent endogenous, and latent exogenous variables were jointly distributed normally with a mean (μ) and variance-covariance matrix ($\sum$) (StataCorp, 2017). The coefficients reported are standardized coefficients which can be interpreted as the change in one variable given a change in another, both measured in standard deviation units (StataCorp, 2017).

3. Results

3.1 Demographics of Respondents

LandownersParticipants included in this study were 95% male and 5% female. The race composition was 82% white American, 14% Native American, and 4% identified as more than one race. About half of the respondents (48%) reported their primary job as farmers/rancher, 23% as retired, 11% as business, 5% as working class (physical work), and 3% as medical-related. The remaining 10% of the responders held jobs unidentified in the survey. The average age of respondents was 63 (SD = 12) years. The percentage of respondents with a General Educational Development (GED)/high school degree or below was 28%, some college experience was 20%, associate or technical degree was 12%, bachelor's degree was 22%, and graduate degree was 18%. Of note, NWOS data suggest that average age of landowners having 10+ acres of forestland in Oklahoma was 66 years and that about 53% had college degree and 24% were minorities (USFS, 2021). To this end, our results are similar to average family forest landowners in Oklahoma although the numbers are not directly comparable as we limited our sample pool to those having 160 acres. Finally, the early and late response bias was not significant among responders from the first and second lots of survey and postcards mailing. These results suggest that non-response bias in not a major concern among our respondents.

3.2 Measurement and Structural Variables, and their Factor Loadings

Cronbach alpha, factor loadings, and their standard deviation of observed variables in their respective latent construct, mean, and standard deviation of variables are presented in Table 1. Subjective norms consisted of observed variables *e1value*, *e1diverse*, *e1support*, and *e1livable* variables. Attitudes consisted of variables *e3manage*, *e3effort*, *e3wilder*, and *e3overall*. Moral norms were represented by variables *e2respect*, *e2maintain*, and *e2invest*. Cronbach's alpha value of subjective norms, attitudes, and moral norms was above the value suggested by Cronbach (1951) for internal consistency. Perceived behavior control consisted of variables *e1resource* and

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

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

Measurement Variables in SEM Models	Factor loading (Std. Err.)	Mean (St. Dev.)
Subjective Norms (*SN*): Cronbach Alpha (α) = 0.89		
e1value: Sustainable management of forest, rangeland and deer habitat is important to the people I value most.	0.76 (0.05)	3.82 (1.08)
e1diverse: My family and friends think that forest, rangeland, and deer habitat management could enhance plant and animal diversity.	0.82 (0.04)	3.60 (1.14)
e1support: My family and friends are supportive of forest, rangeland, and deer habitat management activities.	0.90 (0.02)	3.82 (1.04)
e1livable: My family and friends think that forest, rangeland, and deer habitat management would make our environment more livable.	0.81 (0.05)	3.57 (1.12)
Perceived Behavior Controls (*PBC*): Cronbach Alpha (α) = 0.48		
e1resource: I have resource and opportunities to manage my land for forest, rangeland, and deer habitat management.	0.48 (0.09)	3.49 (1.16)
e1improve: I think that I can improve forest, rangeland, and deer habitat on my property by actively managing them.	0.68 (0.10)	3.95 (0.98)

Moral Norms (*MRL*): Cronbach Alpha (α) = 0.82		
e2respect: I give respect and courtesy to people who are involved in forest, rangeland, and deer	0.71	4.24
habitat management.	(0.05)	(0.86)
e2maintain: I feel that I should actively manage forest, rangeland, and deer habitat on my property	0.90	3.95
to maintain deer habitat for deer and wildlife.	(0.03)	(1.00)
e2invest: I feel honored to invest money, time, and resources to manage forest, rangeland and deer	0.77	3.58
habitat for deer and wildlife habitat.	(0.04)	(1.18)
Attitudes (*ATT*): Cronbach Alpha (α) = 0.87		
e3manage: I am satisfied with the overall characteristics of forest, rangeland, and deer habitat that I	0.67	3.65
maintain.	(0.06)	(0.96)
e3effort: I am satisfied with the number of deer and wildlife that I observed with the management	0.83	3.72
effort that I put in my property.	(0.04)	(1.06)
e3wilder: I am satisfied with the wilderness of forest, rangeland, and deer habitat that I maintain.	0.88	3.66
	(0.03)	(1.00)
e3overall: I am satisfied with the overall benefits I am getting from forest, rangeland, and deer	0.77	3.58
habitat that I manage.	(0.05)	(1.04)
Intentions (*INT*): Cronbach Alpha (α) = 0.44		

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)	0.66 (0.08)	61.51 (106.37)
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)	0.54 (0.09)	20.25 (27.90)
c6interest: Are you interested in knowing more about active forest or rangeland management in Oklahoma?	0.37 (0.07)	0.60 (0.49)

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Among our respondents, the majority of landowners agreed or strongly agreed (henceforth, agree) that sustainable ecosystem management for deer habitat is important for the people they value most (*e1value*). Similarly, the majority of landowners agreed that their family and friends think that forest, rangeland, and deer habitat management could enhance biodiversity (*e1diverse*). Sixty-eight percent of respondents agreed that they feel supported by their friends and families for the active management (*e1support*). Fifty-six percent of landowners agreed, 21% disagreed, and 23% remained neutral that they have resources and opportunities to actively manage their land (*e1resource*). Seventy-four percent of landowners strongly agreed that they can improve their forest, rangeland, and deer habitat by actively managing their land (*e1improve*).

~~Eightly~~Eighty-seven percent of landowners agreed and 10% of landowners remained neutral on the statement ~~stating~~ that they give respect and courtesy to people involved in the forest, rangeland, and deer habitat management (*e2respect*). Sixty-eight percent of landowners agreed that they should actively manage their land to maintain deer and wildlife habitats (*e2maintain*). However, only 52% of landowners felt honored in investing their money, time, and resources in managing their forest and rangeland (*e2invest*); 47% of landowners either remained neutral or disagreed with the statement that they feel honored to invest money, time, and resources to manage their land.

Among our responders 65% of landowners stated that they are satisfied with the overall characteristics of the forest and rangeland they managed (*e3manage*). Sixty-three percent of landowners agreed, 24% of landowners remained neutral, and 13% disagreed that they were satisfied with the number of deer and wildlife observed based on their management effort (*e3wilder*). Sixty percent of landowners agreed, 25% remained neutral, and 15% disagreed that they are satisfied with the overall benefit they are getting from their forest and rangeland.

3.3 Model Results

The model fit statistics exhibited a good fit for the four models representing TRA, TRA-moral, TPB, and TPB-moral (Table). SEM model results ~~to test~~testing 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 the presentation.

Table 2: SEM Model fit statistics for all four models along with the sample size used in each model.

Fit Statistics\Models	TRA	TRA-moral	TPB	TPB-moral
Model vs. saturated (MS) Likelihood ratio test: (χ^2):	43.89	85.87	72.44	121.72
Baseline vs. saturated (BS) Likelihood ratio test: (χ^2):	823.04 ***	1212.59 ***	937.14 ***	1333.33 ***
Satorra-Bentler scaled test (MS) (χ^2):	30.361	63.76	52.00	91.88
Satorra-Bentler scaled test (BS) (χ^2):	612.77 ***	932.48 ***	709.53 ***	1034.54 ***
Root mean squared error of approximation (RMSEA):	0.02	0.04	0.04	0.04
RMSEA lower Bound:	0.00	0.00	0.00	0.01
RMSEA Upper Bound:	0.06	0.06	0.06	0.06
P-close (Probability RMSEA ≤ 0.05):	0.88	0.81	0.76	0.74
Satorra Bentler RMSEA (SB RMSEA):	0.00	0.00	0.00	0.00
Comparative Fit Index (CFI):	1.00	0.99	0.98	0.98
Satorra Bentler CFI(SB CFI):	1.00	1.00	1.00	1.00
Tucker Lewis Index (TLI):	1.00	0.98	0.98	0.97
Satorra Bentler Tucker-Lewis index (SB TLI):	1.03	1.01	1.02	1.00
Standardized root mean squared residuals (SRMR):	0.04	0.41	0.05	0.05
Coefficient of determination (CD):	0.99	0.99	0.99	0.99
Akaike's information criterion (AIC):	4187.33	5280.93	5108.11	6177.32
Sample Size (N)	165	165	165	165

Model summary statistics for TRA and TRA-moral are given in Table 3. In the TRA model (Figure (3a)), the subjective norm significantly affected intentions for active management of forest, rangeland, and habitat for deer hunting (henceforth, intentions) supporting H_1. However, attitude significantly affected intentions but showed a negative sign in the TRA model thus partially supporting H_2. In the TRA-moral model (Figure (3b)), subjective norms did not significantly or directly affect intentions, rejecting H_1, but indirectly affected intentions through moral norms. Subjective norms significantly affected moral norms, and moral norms significantly affected intentions positively, thus supporting H_5 and H_7 respectively. Attitude significantly but negatively affected intentions, thus, partially supporting H_2. Attitude did not significantly affect moral norms, thus rejecting H_3.

~~In the TPB model (Figure (4a)), subjective norms and perceived behavior control did not affect intentions, thus not supporting H_1 and H_4. Like previous models, attitude significantly affected intentions and hasd a negative sign, thus, partially supporting H_2. In TPB-moral (Figure (4b)),the subjective norm did not directly affect intentions, again failing to support H_1. Subjective norms indirectly affected intentions through moral norms, like the TRA-moral model. Subjective norms significantly affected moral norms and moral norms significantly affected intentions with a positive sign, again supporting H_5 and H_7 respectively. Attitude again directly affected intentions and retained a negative sign, 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 given in .~~

Table 3: Standardized Setorra-Bentler coefficients of four SEM models (TRA, TRA-moral, TPB, and TPB-moral).

Structural Variables	TRA	TRA-moral	TPB	TPB-moral
	Coeff. (Std. Err.)	**Coef. (Std. Err.)**	**Coef. (Std. Err.)**	**Coef. (Std. Err.)**
SN ➔ *INT*	0.46 *** (0.097)	- 0.16 (0.21)	0.23 (0.20)	- 0.17 (0.20)
ATT ➔ *INT*	- 0.21 * (0.12)	- 0.31 ** (0.11)	- 0.36 ** (0.16)	- 0.33 *** (0.12)
MRL ➔ *INT*	-	0.84 *** (0.26)	-	0.80 *** (0.30)
PBC ➔ *INT*	-	-	0.42 (0.28)	0.07 (0.22)
SN ➔ *MRL*	-	0.75 *** (0.05)	-	0.52 *** (0.14)
ATT ➔ *MRL*	-	0.12 (0.08)	-	-
PBC ➔ *MRL*	-	-	-	0.39 ** (0.16)

Note: Coef. = Standardized correlation coefficients (StataCorp, 2017), Std. Err. = Satorra-Bentler robust standard error of coefficients. *SN* ➔ *INT*: subjective norms (*SN*) impact Intentions (*INT*) 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 * = $p < 0.10$

In the TPB model (Figure (4a)), subjective norms and perceived behavior control did not affect intentions, thus not supporting H_1 and H_4. Like previous models, attitude significantly affected intentions and had a negative sign, thus, partially supporting H_2. In TPB-moral (Figure (4b)),the subjective norm did not directly affect intentions, again failing to support H_1. Subjective norms indirectly affected intentions through moral norms, like the TRA-moral model. Subjective norms significantly affected moral norms and moral norms significantly affected intentions with a positive sign, again supporting H_5 and H_7 respectively. Attitude again directly affected intentions and retained a negative sign, 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 given in Table .

Unlike the stated hypotheses, attitude consistently showed a negative sign in all four models. Also, subjective norms had negative signs when moral norms were added to the model; regardless, subjective norms were not significant in either model that included moral norms. However, the pairwise correlation coefficients among subjective norms and attitudes were positive and significant in all four models. Also, subjective norms and perceived behavior control, and subjective norms and attitudes were positive and significant in TPB and TPB-moral models (Table ~~Table 4~~).

Table 4: 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
	Coef. (Std. Er.)	**Coef. (Std. Er.)**	**Coef. (Std. Er.)**	**Coef. (Std. Er.)**
*SN*ATT*	0.40 *** (0.09)	0.40 *** (0.09)	0.40 *** (0.09)	0.40 *** (0.09)
*SN*PBC*	-	-	0.71 *** (0.11)	0.69 *** (0.10)
*PBC*ATT*	-	-	0.59 *** (0.10)	0.56 *** (0.09)

Note: SN*ATT: Standardized correlation coefficient (StataCorp, 2017) between subjective norms (SN) and attitudes (ATT). Dashes (-) indicate irrelevant relationship in the model. *** = $p < 0.001$, ** = $p < 0.05$ and * = $p < 0.10$.

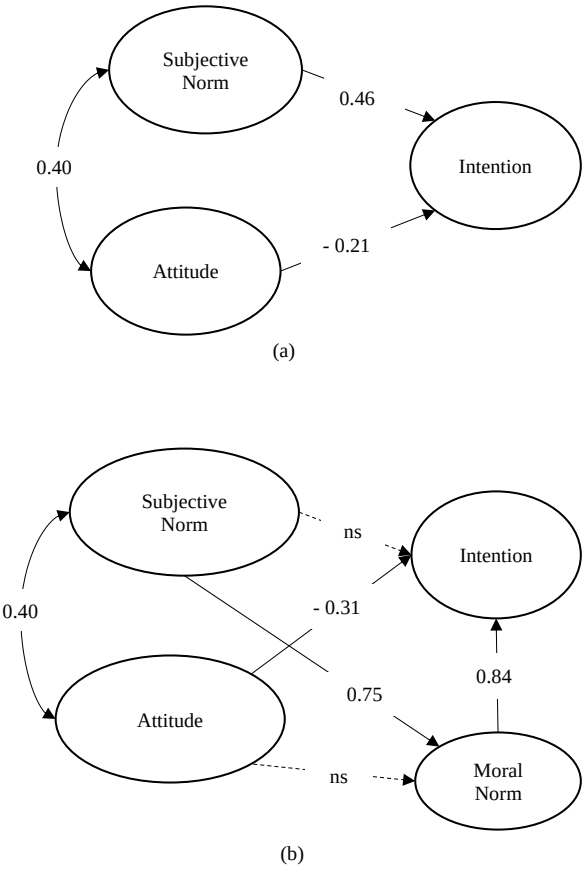

Figure 3: (a) Theory of Reasoned Action (TRA) and (b) Theory of Reasoned Action with Moral Norms (TRA-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" relationships, respectively.

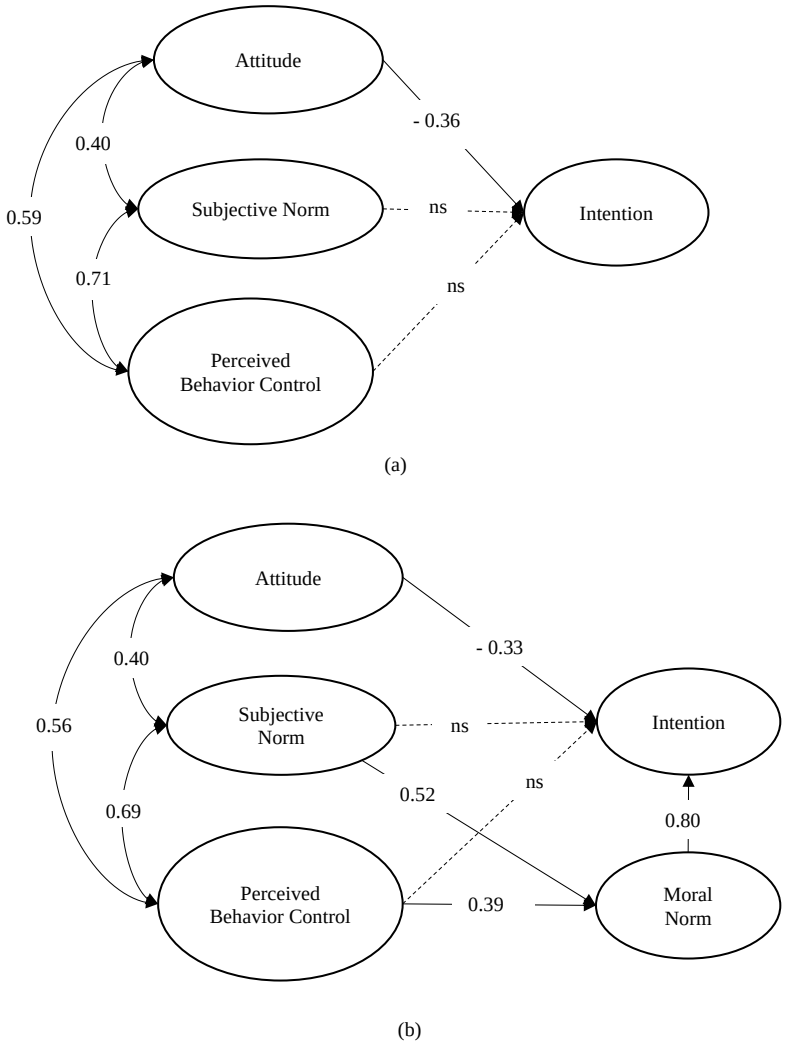

Figure 4: (a) Theory of Planned Behavior (TPB) and (b) Theory of Planned Behavior with Moral Norms (TPB-moral). Values on the arrow and "ns" indicate coefficients and "non-significant" respectively.

4. Discussion

Previous research indicated that Oklahoma landowners were supportive of active management using prescribed burning (Elmore et al., 2010) but were concerned about addressing associated risk, liability issues (Elmore et al., 2010; Kaur et al., 2020; Starr et al., 2019a), and financial burden (Kaur et al., 2020; Starr et al., 2019a). Fire suppression and exclusion since the mid-1900s have 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 forest-grassland transition zone. Within this context, our research determined how landowners' attitudes, perceived behavior control, moral norms, and subjective norms influence active management of forest and rangeland to improve deer habitat or deer hunting revenue.

Our results showed that landowners had positive social pressure (subjective norms). Three statements representing subjective norms in our models also showed that landowners feel supported by family and friends for the management of the ecosystem for deer habitat management. Landowners felt positive social pressure from friends and family and further agreed that managing land is important for the people they value most which displays two-way motivations for landowners to actively manage their land. Landowners in this region had further realized the need for active management, which can help meet the integrated forest and range management needs in this region.

The research further found that landowners had a positive perception of their ability to actively manage their land (perceived behavioral control). The positive peer pressure coupled with positive perceived behavioral control were important in driving the active management of the ecosystem of in south-central transitional ecoregion. However, we found that many landowners believe that they lacked resources and opportunities to manage their land. Access to resources could create opportunities and motivate landowners to actively manage their land to improve the quality of forests, rangeland, and deer habitat. Landowners in this region cited the uncertainty of the timber market, lack of interest from manufacturers, and low-quality resources as a hindrance to the market (Starr et al., 2019b) which could be a further indication of a lack of resources and opportunities.

This research further found that landowners expressed strong positive moral support to people involved in the active management of forest, rangeland, and deer habitat. Most of the landowners showed positive moral support towards personnel involved in active management and agreed that they should be involved in active management. However, slightly over half landowners only felt proud to invest their time, money, and resource in actively managing land in this region which can be better understood by relating to landowners' satisfaction with their forest and grassland. Still, more than one-third of landowners were not satisfied with the characteristics of their forest and rangeland, the number of deer and wildlife observed, and the overall benefit they are receiving from their property. This means even though landowners are generally positive about actively managing their land, the overall benefit and the characteristics of their forest and rangeland could not fully meet their expectations, which might be hindering the active management. The dissatisfaction of landowners resulting from the poor performance of their land might be a reason behind the negative attitude observed in our SEM models. Attitude is the reflection of the behavioral belief that originated from an individual's experience of acting (Ajzen, 2002). Previous research had further suggested that financial burden (Kaur et al., 2020; Starr et al., 2019a) and fire liabilities (Elmore et al., 2010; Joshi et al., 2019a; Starr et al., 2019a) as major demotivating factors for landowners to actively manage their land.

The pairwise correlations among subjective norms, perceived behavior control, and attitude were positively correlated signifying that the landowners with positive subjective norms and perceived behavior control tend to have a positive attitude towards active management (Table 5). The positive correlation is an indication that the landowners were mostly positive about actively managing their land~~,~~ which suggested a strong need for active management to increase overall satisfaction and increase revenue from forest and rangelands in the south-central transitional ecoregion. Addressing associated risk and liabilities issues and financial burdens could change the attitude of landowners and thus positively affect the intentions of positively towards actively managing their land. The associated risk and liabilities issues can be addressed through extension and outreach programs (Elmore et al., 2010; Joshi et al., 2019a). The financial burden can be offset by helping landowners to realize the potential source of revenue by actively managing their land (Starr et al., 2019a) for activities such as deer hunting.

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 for deer hunting. The behavior, management of land for deer hunting, is under the volitional control of our study population

because they own at least 160 acres of land. This is likely why the behavior is best explained by TRA (Madden et al., 1992).

Perceived behavior control and intentions in SEM models have lower Cronbach alpha values. Low Cronbach alpha values are not uncommon in SEM models. Lopez-Mosquera and Sanchez (2012) also reported a lower than suggested Cronbach alpha value for perceived behavior control and intentions. Further, intentions had a wide range of factor loading, from 0.37 to 0.66. This could be because intentions, unlike other variables, are not measured on the Likert scale. Latent constructs often have lower Cronbach alpha coefficients because of random error, even with meticulously planned variables (Ajzen, 2011).

This paper studied landowners' attitudes, perceptions, and social and peer pressure related to active management of ecosystem using SEM which broadened the scope of wildlife management research through the inclusion of moral norms in TRA and TPB models. From an applied standpoint, our results suggest that forest landowners in the grassland-forestland ecotone have several motivations to adopt active forest management, which can be revealed from positive peer and family pressure, positive moral norms, positive feelings about active management, and positively perceived ability to manage. However, as the attitude statements reveal, many landowners are satisfied with the *status quo*, which could be the major reason behind the negative relationship between 'attitude' and 'intention' to know or invest more in active management activities. Perhaps these landowners feel that while active forest management involving thinning, prescribed fire, and herbicide applications are needed for timber-oriented forest management, it may not be necessary to improve wildlife habitat. This disconnect between landowner perceptions and the science of forest management needs to be addressed through field demonstration and other forms of extension.

A couple limitations of this study is worth nothing. ~~Socio~~The ~~-demographics~~sociodemographic of our survey respondents are similar to average family forest landowners in Oklahoma, although the numbers are not directly comparable as we limited our sample pool to those having 160 acres. Likewise, there was no statistical difference in socio-demographics between early and late respondents, which is commonly used method for non-response bias analysis (Joshi et al. 2019). Nonetheless, our response rate is less than desirable, causing some concern for non-response bias. Also, in one of the statements defining attitude, we asked respondent to reveal whether they are satisfied with the wilderness of forest, rangeland, and deer habitat. Although very high value of Cronbach's alpha (0. 87) suggests that the landowner responses to this statement were mostly consistent with other statements,

landowners may not characterize medium-sized, managed private land as wilderness. Despite these caveats withstanding, this paper introduced new ways to expand these two well-established theories. We believe TRA, TPB, and moral norms can and should be expanded in the human dimension and wildlife management research. Furthermore, the use of TPB and TRA for other species, and the expansion of these theories using moral norms in the hunting research are yet to be understood fully. Also, TPB is criticized for ignoring human emotions, identity, and moral values (Miller, 2017) which are addressed by this paper by expanding theories by adding moral norms as suggested (Ajzen, 1991). The recent development of TPB is more suggestive of mediating the 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). Since our study is primarily focused on exploring the role of moral norms in traditional realm of TBP and TRA, future research highlighting mediating role of socio-demogrpahic variables will likely provide additional insights.

5. Conclusion and Management Implications

This research provided a holistic and broader picture of landowners' intentions towards actively managing their land for deer habitat management which can be crucial in designing Extension and outreach programs. The realization of increased revenue by maintaining healthy and resilient forests can drive active management in this region (Starr et al., 2019a). The findings of this research provide an assurance of positive peer pressure, moral support, feeling of self-sufficiency, and intentions towards active management. Our findings are consistent with the previous research indicating high support for prescribed fire but some degree of hesitancy when it comes to adoption (Elmore et al., 2010). As previous research indicates, fire and related liability issues (Elmore et al., 2010; Starr et al., 2019a) and financial burdens (Starr et al., 2019a) remain obstacles for active management, which can be overcome through Extension and outreach programs (Elmore et al., 2010; Starr et al., 2019a). Outreach and Extension programs can help landowners realize increased revenue due to active management as well as reduce liabilities. The perceived risk and liabilities of fire decrease with the increase in knowledge and experience associated with prescribed burning (Joshi et al., 2019a).

Landowners show respect to those involved in the active management of ecosystems. Landowners are further supportive of actively managing their land for deer hunting by maintaining a good deer habitat and having

positive social pressure from friends and family. Landowners, however, are not satisfied with the management outcomes. The positive sentiment of landowners towards active management but below expected outcome can be turned into an opportunity to motivate landowners to actively manage their land for deer hunting and increase revenue as well as revitalize deer hunting activities.

In summary, landowners are generally appreciative of active management, which is further supported by their family and peers. However, landowners seemed to be content with the existing conditions of wildlife habitats and do not see a need for additional investments. Although, the management cost associated with active management can be in part offset through hunting leases; improved deer habitat through active management could motivate deer hunters to pay more money per acre as a lease fee. Based on our research we suggest extension specialists and policymakers focus on educating landowners to make them aware of the cost and benefits associated with active management. This could enhance the confidence of landowners in adopting active management tools and realizing financial benefits. The realization of reduced risk and added financial benefits could motivate landowners to adopt management tools in their forests and rangeland.

Stakeholders from government, non-profit organizations, and industry believe that an increase in investment and financial assistance programs could enhance the active management of the ecosystem in this region (Starr et al., 2019a). These types of programs could drive active management and help landowners to increase their revenue in the short run. Whereas, in the long run, it could help landowners to understand the importance of active management using prescribed fire to maintain quality wildlife habitat and reduce the encroachment of invasive species in this region (Joshi et al., 2019b).

374 **Additional Material:**

375 *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 (%)
e1govt: It would be difficult to conduct forest, rangeland, and deer habitat management without government support.	21.8	22.4	22.4	18.2	15.2
e1commun: It would be difficult to conduct forest, rangeland, and deer habitat management without support from the community.	27.3	20.6	27.9	20.0	4.2
e2harvest: Excessive harvesting of natural resource may limit their use for the future generation.	7.3	3.0	13.9	33.9	41.9
e3benefit: Active Forest, rangeland, and deer habitat can bring economic as well as environmental benefits.	4.2	6.7	15.8	42.4	30.9
e3human: The primary use of forest, rangeland, and deer habitat management should be to benefit human beings.	8.5	16.4	26.0	32.1	17.0
e3restrict: Restricting excessive use of forest, rangeland, and deer habitat can enhance recreational opportunities.	8.4	15.2	33.3	27.3	15.8
e3time: It is important to spend time managing forest, rangeland, and deer habitat.	2.4	3.6	23.6	38.2	32.2
e3balance: Sustainable management of forest, rangeland, and deer habitat is important to maintain balance and diversity in the natural environment.	3.0	3.6	17.6	40.6	35.2

e3connect: I feel connected with nature when I get involved in forest, rangeland, and deer habitat management.	3.0	4.2	24.2	37.6	31.0
e3environ: The primary use of forest, rangeland, and deer habitat management should be to benefit the environment.	4.9	7.9	34.5	33.3	19.4
e3noneed: There is no need for active, forest, rangeland, and deer habitat management.	45.5	30.8	15.8	3.0	4.9

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