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Original Article

Multi-attribute Preferences for Northern Bobwhite Habitat Restoration among Texas Landowners

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ABSTRACT Northern bobwhite (*Colinus virginianus*) abundance has declined range-wide over the long term due to factors such as habitat loss and deterioration. Private land management is critical to bobwhite conservation because most bobwhites occur on private lands, but little research has been conducted regarding how private land managers and landowners make decisions about whether and how to restore northern bobwhite habitat. To begin addressing this deficit, we used a choice-based conjoint approach to determine how Texas, USA, landowners and land managers (surveyed in November 2017) weigh the importance of northern bobwhite hunting opportunities, costs, and labor when making habitat restoration decisions. We also used a latent class analysis to break respondents into segments based on their valuations of these attributes. The results of our latent class analysis indicate that managers and landowners can be grouped into several segments, and most segments do not place a high value on bobwhite hunting opportunities, but instead are more interested in minimizing out-of-pocket costs and labor input. Bobwhite habitat restoration programs yielding cost shares ≥50%, labor inputs at ≤30 days/year, and likely coveys flushed per hunting day >4 broadly appealed to landowners; however, ensuring low labor costs was most important, particularly for pragmatic landowners. This indicates that policies minimizing labor inputs and maximizing cost shares may be preferred over increasing hunting opportunities. Finally, we discuss the management preferences and practices of the segment most interested in maximizing bobwhite hunting opportunities and potential outreach strategies for segments of opportunistic and pragmatic landowners who may be persuaded to manage for bobwhite habitat if they perceived this management as economically viable. © 2019 The Authors. *Wildlife Society Bulletin* Published by Wiley Periodicals, Inc.

KEY WORDS choice-based conjoint analysis, *Colinus virginianus*, landowner preferences, latent class analysis, northern bobwhite, private lands conservation.

Northern bobwhite (*Colinus virginianus;* hereafter, bobwhite) abundance across the United States has declined for decades with ongoing landscape and climatic changes, suggesting conservation of this species will only grow more difficult. This long-term decline in bobwhite abundance is due to multiple drivers including habitat loss and deterioration, intensive farming, livestock grazing practices, invasive species introductions, and possibly other factors such as agricultural pesticides and diseases (Brennan 1991, Peterson et al. 2002, Hernández et al. 2013). Remaining bobwhite populations will face further pressure as increasing urbanization and agricultural intensity eliminate quality habitat and climate change increases risks of heat stress and severe climatic events including droughts and hurricanes (Hernández et al. 2013).

Conservation actions on private lands will likely shape the future for bobwhites. Most land in the bobwhite's range is privately owned and intensification of production on these lands has decreased available bobwhite habitat (Brennan

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1991, 2007, Peterson et al. 2002, Hernández et al. 2013). Recommendations for bobwhite restoration suggest that instead of continuing to focus on fine-scale management (e.g., planting food plots) and statewide hunting regulations, bobwhite restoration should instead focus on regional management of usable space and harvest management at similar regional scales (Williams et al. 2004). In line with these recommendations, identification and development of focal areas—or quality bobwhite habitat across multiple properties—has become a top priority for bobwhite restoration (Morgan et al. 2016). Focal areas should yield greater bobwhite densities if multiple landowners, in nearby proximity, are managing for bobwhite habitat.

Given the importance of private lands to northern bobwhite conservation, there is a need to understand landowners' management decisions in this context. Much of the research in this area focuses on economic costs and benefits associated with managing for bobwhites, and identifying incentives to support management, including conservation payment programs (Rollins 2002, Burger et al. 2006, Huang 2009). Although a small percentage of landowners purchase land solely with the intent of managing and hunting bobwhites, only in rare cases have they generated bobwhite hunting-related income rivaling income generated from cattle grazing leases (Rollins 2002, Daley et al. 2004, Conner 2007). Most landowners with large parcels of land manage primarily for crop, forestry, or cattle production, and would likely lose income by shifting land use from those areas to bobwhite habitat (Burger 2002, Burger et al. 2006, Brennan 2007, Hernández et al. 2013). To manage and restore bobwhite habitat, biologists and managers often recommend intensive management actions such as prescribed fire and other forms of brush management (e.g., mechanical or chemical approaches; Jackson et al. 1990, Hernández and Guthery 2012). However, a survey of Virginia, USA, landowners engaged in conservation cost-share programs indicated that fire management was less commonly implemented than less expensive management actions such as developing riparian buffers (Jagnow et al. 2008). Implementation of intensive bobwhite habitat management practices, such as brush management using prescribed fire or mechanical or chemical techniques, is limited in part because these approaches are expensive to implement (Jones and Chamberlain 2004, Hernández and Guthery 2012). Barriers to prescribed fire go beyond cost and include landowner risk perceptions, concerns about liability, and lack of contractors able to burn (Kreuter et al. 2008). Additionally, landowners often are reluctant to enter conservation easements because these programs can require long-term agreements, be inflexible, or infringe on landowners' self-determination—their ability and desire to make land management decisions independently (Ramsdell et al. 2016).

Other factors potentially influencing the decision to manage for bobwhite habitat include expected labor requirements, and uncertainty of successfully promoting bobwhite populations through the management action being considered. Although the importance of labor has not been a research focus for conservation on private lands, it may be of particular importance for bobwhite habitat management. Research on financial incentives for conservation on private lands often has focused on protecting species by simply avoiding or not disturbing known habitat (Ramsdell et al. 2016). Programs such as the mountain plover (*Charadrius montanus*) prelisting conservation program in the midwestern United States, for example, require farmers to create small (3–5-m^2) buffers around nests (Ramsdell et al. 2016). In contrast, restoring bobwhite habitat often includes intensive, multiyear brush management plans requiring considerable labor (Jones and Chamberlain 2004). Similarly, overgrazing by livestock degrades bobwhite habitat, but grazing management plans that limit livestock numbers may affect a landowner's bottom line (Lusk et al. 2002, Rollins 2002). Bobwhite populations also are prone to fluctuations dependent on factors such as variation in precipitation, which are outside landowners' control (Bridges et al. 2001, Hernández et al. 2005, Hernández and Peterson 2007). In sum, landowners may be hesitant to even attempt managing for bobwhite habitat if they are uncertain about being able to restore bobwhite populations, costs of management are too high, or labor requirements are too great (Horn 2015).

We build on these studies using a choice-based conjoint model to simultaneously evaluate the relative importance of multiple attributes of northern bobwhite habitat management in Texas, USA. This represents a crucial step for understanding wildlife habitat management on private lands because the costs and benefits of most decisions are typically complex and interact with each other (Daley et al. 2004, Sorice et al. 2012). Given this context, the social science exploring decision-making is often overly simplistic unless it accounts for tradeoffs between multiple outcomes (Holmes and Boyle 2003). Stated preferences methods that incorporate choice models, can be used to identify attribute preferences and tradeoffs that are important in complex decision-making contexts (Holmes and Boyle 2003, Serenari et al. 2019). Previous qualitative research regarding northern bobwhite management in Texas found landowners and managers (hereafter, landowners) identified hunting opportunities, cost-share programs, and labor costs as the 3 most critical decision attributes relevant to bobwhite management (Horn 2015). Our objective was to use a case study of Texas landowners to measure tradeoffs associated with these 3 decision attributes and identify any distinct groups of landowners with unique bobwhite management decision-making profiles. We used a choice model approach to describe the relative importance of the 3 attributes and their levels; we then used latent class analysis to establish segments of landowners and compare practices and preferences among the population segments. Landowners in Texas represent a critical cohort for research because areas in Texas, including the Rolling Plains (northwest Texas) and Rio Grande Plains (south Texas), include some of the most expansive remaining bobwhite habitat remaining (Rollins 2002, 2007; Hernández et al. 2007). Additionally, >95% of land in Texas is privately owned and 83% of land is rural (Anderson et al. 2014). Although our primary objective was descriptive, we tested several hypotheses. From an

economic perspective, we first expected bobwhite hunting opportunities to be the least important attribute because bobwhites only generate income for a small percentage of Texas landowners (Rollins 2002). Second, we expected to find nonlinearity in the importance of attribute levels for each of the 3 decision criteria. Describing these nonlinear relationships is critical for wildlife managers because they would suggest increased hunting opportunities, increased conservation payment cost-share, and decreased labor requirements only influence landowner decisions beyond thresholds. Thus, for example, raising labor requirements up to a minimal threshold may have no influence on decisions, but large negative changes regarding willingness to conduct wildlife management after the threshold is reached.

METHODS

Sampling

We generated our sample frame from a list of hunters in Texas, using contact information from the Texas Parks and Wildlife Department's hunter license point-of-sale system. The database included 20,010 unique e-mail addresses of hunters who purchased upland game bird stamps for the 2012–2013 hunting season through the 2016–2017 hunting season. Of those e-mail addresses, 701 were invalid and excluded from follow-up attempts. Texas Parks and Wildlife Department distributed e-mail invitations with links to our survey. We sent the initial survey invitation in November 2017. During the following 3 weeks, we sent 3 e-mail reminders, 1/week (Dillman et al. 2014). A total of 2,610 people responded to the survey for a response rate of 13.52%. Among these respondents, 617 self-identified as land managers or landowners in Texas. This subset of respondents who make land use decisions received the choice-based conjoint questions. Although geographic and cultural diversity within Texas could create unique localized perspectives regarding bobwhite management, sample size was insufficient for using a choice-based conjoint approach on subsets of the statewide sample.

To evaluate for nonresponse bias, we used the continuum of resistance model (Serenari et al. 2015). This analytic approach is based on the assumption that the level of effort required to elicit a response indicates an individual's willingness to respond, so late respondents are comparable to nonrespondents (Kypri et al. 2004). We divided respondents into 3 groups based on response time: early respondents (after the first e-mail; $n = 1{,}020$), intermediate respondents (after the first reminder and before second reminder; $n = 679$), and late respondents (after the second reminder; $n = 911$). We compared respondent groups based on demographic variables. Analysis of variance (ANOVA) results indicated no differences between respondent groups for education level, household income, or age, and chi-square test results indicated no differences for ethnicity or gender. We detected a bias for more respondents with rural upbringing within the initial response group ($\chi^2_2 = 7.57$, $P = 0.023$). This coincides with previous studies and continuum resistance theory because response rates to internet surveys tend to be greater in rural than urban areas (Dillman et al. 2014). The Cramer's V-value for this association was 0.059, indicating a 'very weak' association (Davis 1971). Given the weak association and expectation that rural respondents should respond more in the first response group than urban respondents, we did not weight this variable during further analyses.

Questionnaire Development

We used 10 focus groups, each with 5–10 participants, to evaluate key variables and design questionnaire items to measure perceptions and values of northern bobwhite stakeholders in Texas (Horn 2015). Within these focus groups, the most commonly discussed motivations were economic. Among economic motivations, the top 3 mentioned related to financial assistance or cost-share programs including the U.S. Department of Agriculture Conservation Reserve Program (CRP), management practices that aligned or conflicted with bobwhite management, and hunting as a source of income. Other important motivations for bobwhite management included ecosystem motivations such as managing for grassland landscapes, political motivations such as availability and barriers to enrolling in assistance programs, and cultural motivations such as managing bobwhite for hunting.

We used a choice-based conjoint experiment to simultaneously measure the relative importance of 3 attributes of bobwhite management. In choice-based conjoint experiments, respondents choose between scenarios that present identical attributes with differing attribute values (Orme 2010; Fig. 1). We operationalized the top 3 economic motivations from bobwhite management focus groups into measurable attributes (Horn 2015). We included these attributes (hunting opportunities, cost share, and labor) with 3, 4, and 5 attributes levels, respectively (Table 1). In our survey, each respondent was presented with 10 different choice scenarios, and attribute levels were randomly changed in each of the 10 choice scenarios. We followed Sawtooth's default design parameters, with a balanced overlap approach (Serenari et al. 2015). The survey was designed and hosted using Sawtooth's SSI Web (Sawtooth Software, Orem, UT, USA).

We also measured landowners' attitudes and practices related to bobwhite habitat management. To better understand how the motivations identified in focus groups related to a wider sample of landowners (Horn 2015), we adapted 5-point Likert style scale items (Strongly Disagree = 1, Strongly Agree = 5) from a previous survey of landowners in North Carolina, USA (Burke 2016). We asked whether northern bobwhites:

- Are actively managed,
- Provide hunting opportunities for myself and my family,
- Provide hunting opportunities for other hunters,
- Generate lease income,
- Are a valuable part of the ecosystem,
- Provide wildlife viewing opportunities,
- Should be a part of the landscape,
- Are not worth the effort being put into their management, and/or
- Compete with other more desirable wildlife for resources.

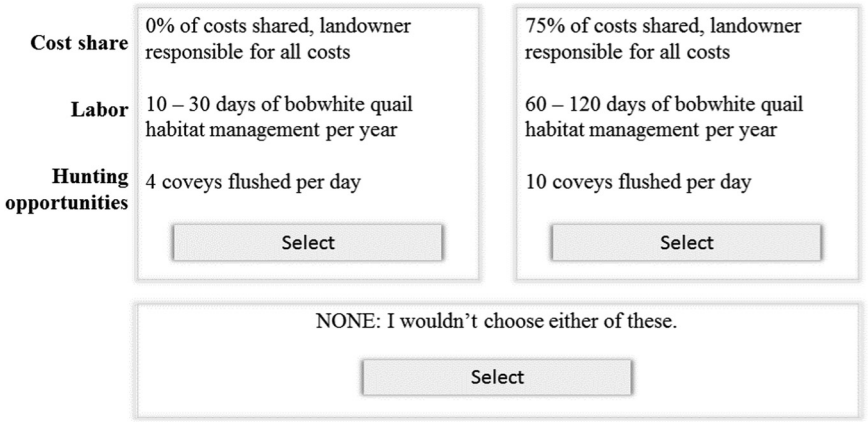

Figure 1. Example of a choice scenario pertaining to the importance of hunting opportunities, costs, and labor when making habitat restoration decisions for northern bobwhites given to landowners and managers in Texas, USA, during November 2017. Each survey respondent received 10 choice scenarios. The attribute levels were randomized for each scenario.

Table 1. Attributes and attribute levels used in conjoint analysis of management preferences among Texas, USA, landowners and managers surveyed in November 2017.

Attributes	Attribute levels
Hunting opportunities—no. of coveys flushed in a day	4 coveys/day 10 coveys/day 16 coveys/day
Cost share—percent (%) of northern bobwhite management costs shared with a wildlife management agency	0% 25% 50% 75%
Labor—no. of work days per year, spent managing for northern bobwhite habitat	<10 days/yr 10–30 days/yr 30–60 days/yr 60–120 days/yr >120 days/yr

To identify land management practices that potentially interfere, compete, or align with bobwhite management, we asked respondents to identify the top 3 objectives for their property from this list:

- Income from agricultural crops,
- Income from hunting leases,
- Income from livestock,
- Land investment or development,
- Hunting,
- Wildlife conservation,
- Maintaining native grasslands,
- Aesthetic enjoyment,
- Recreation, and/or
- Privacy.

Based on bobwhite habitat management recommendations for Texas and common management practices (Brennan 2007, Hernández and Peterson 2007, Hernández and Guthery 2012), we asked mangers and landowners whether the following management actions are implemented on their property:

- Grazing management,
- Brush management (chemical or mechanical treatment),
- Prescribed fire,
- Native grassland restoration,
- Pollinator habitat management,
- Predator control,
- Supplemental feeding, and/or
- Stocking pen-reared bobwhite quail.

Using threats previously identified by northern bobwhite researchers (Brennan 1991, Peterson et al. 2002, Hernández and Peterson 2007, Hernández et al. 2013) and Texas stakeholders (Horn 2015), we asked managers and landowners to identify potential threats to northern bobwhite on their property. Using a 5-point Likert style scale (Strongly Disagree = 1, Strongly Agree = 5) we asked whether the following were threats to northern bobwhite:

- Diminished connectivity between native grasslands,
- Extreme weathers events such as drought,
- Lack of suitable habitat,
- Nonnative grasses,
- Overharvesting by hunters,
- Predators like coyotes or hawks,
- Red imported fire ants,
- Shifting climate regimes, and
- Wildlife diseases.

Habitat fragmentation is a major cause of bobwhite decline and there is a recognized need to manage bobwhite on spatial scales larger than single tracts (Williams et al. 2004, Hernández and Peterson 2007, Peterson 2007), so we asked whether nearby properties also manage for bobwhite. We also collected demographic information including gender, age, ethnicity, formal education level, whether survey respondents grew up in a rural place, and household income.

Before initial questionnaire invitations were sent, we pretested the survey instrument with bobwhite stakeholders, some of whom participated in previous focus group research (Horn 2015). We sent pretest survey invitations to 50 stakeholders, 46 e-mail invitations were successfully delivered,

and we received feedback from 16 stakeholders. Based on their feedback, we made slight alterations to the phrasing of some questions to improve clarity and concision.

Data Analysis

We used Sawtooth Software to calculate individual utility scores for each attribute level (Orme 2010). Hierarchical Bayesian estimation was employed to extract individual utility scores (Jervis et al. 2012). We then rescaled utility scores using a zero-centered differences method, allowing for direct comparison of attribute utility scores (Orme 2010). We also calculated importance scores, which measure the percent importance that each attribute has for respondents' choices. We calculated importance scores by dividing the utility score range for each attribute by the total utility range and multiplying by 100 (Orme 2010, Serenari et al. 2015). We also used individual root likelihood (RLH) values to prevent underestimation. The RLH is a prediction of respondent choices; we used an RLH minimum threshold of 0.333 when analyzing data (Jervis et al. 2012). The RLH value for every respondent exceeded this threshold, so all respondents' utility scores were used in subsequent analysis.

We employed a latent class analysis to categorize respondents with similar utility scores into segments. We used Bayesian Information Criterion (BIC) to select between models with 2, 3, 4, and 5 segments (Ehrlich et al. 2017). The 5-segment model outperformed the other models (5-segment model BIC = 9,275.3; 4-segment model resulted in second lowest score, BIC = 9,364.3). Following the latent class analysis, we treated segment membership as an independent variable (Boxall and Adamowicz 2002), allowing for the comparison of utility scores between segments (Ehrlich et al. 2017). We also used segment membership to measure associations with bobwhite habitat management actions, values, and threat perceptions. We analyzed data for these associations using Stata 14.2 (StataCorp LLC, College Station, TX, USA).

RESULTS

Descriptive Statistics

Respondents were mostly male (96.6%) and white (93.4%; Table 2). Respondents' educational attainment varied: 32.8% had not attained a bachelor's degree, 36.8% had attained a bachelor's degree, and 30.4% reported having a professional or graduate degree. The mean age of the respondents was 55.3 years old. Almost half of the respondents (45.6%) reported living in a rural area before turning 18 (Table 2). Both the mean and median reported annual household income level was US$100,000–150,000. Landowners and managers were similarly mostly male (94.4%) and white (92.4%; Table 2). The mean age of these respondents was 54.4 years old and nearly half (48.5%) lived in a rural area before turning 18 (Table 2). Among all landowners and managers ($n = 801$), 341 (42.6%) owned property supporting bobwhites, 169 (21.1%) managed property with bobwhites, and 291 (36.3%) owned or managed property where bobwhite did not occur. Among landowners without bobwhites, 72.8% reported that they would like to have bobwhite on their property.

Landowners perceived extreme weather events, such as drought, as the greatest threat to bobwhite on their property (Table 2). Natural predators and red imported fire ants (*Solenopsis invicta*) were the next greatest perceived threats, respectively (Table 2). Overharvest by hunters was perceived as the lowest threat (Table 2). Nearly half (45.75%) of landowners responded that they were not certain whether nearby properties managed to benefit bobwhites, whereas 30.75% maintained these properties were not managed to benefit bobwhites, 18.75% argued some nearby properties were managed to benefit the species, and only 4.75% responded that many nearby properties were managed to benefit bobwhites.

Choice-based Conjoint Analysis

The average importance scores indicate that labor was the most important attribute among all respondents and supported our hypothesis that bobwhite-hunting opportunities are the least important attribute. Results of a one-way ANOVA ($F_{1,848} = 178.36$, $P < 0.001$) and Tukey-HSD (honestly significant difference) *post hoc* tests indicate that labor ($\bar{x} = 43.51$, SE = 0.73) was more important than cost share ($\bar{x} = 30.01$, SE = 0.64), or hunting opportunities ($\bar{x} = 26.48$, SE = 0.73). A Tukey-HSD *post hoc* test also indicated that cost share was more important than hunting opportunities ($P < 0.001$).

Table 2. Respondent demographics, Texas, USA, landowner demographics, and threat perceptions of population surveyed in November 2017 regarding the importance of attributes in making habitat restoration decisions for northern bobwhites.

Landowners and managers	% or $\bar{x}$	SE	All respondents	% or $\bar{x}$	SE	Threat perceptions (response scale 1–5)	$\bar{x}$	SE
Sex (male)	94.4		Sex (male)	96.6		Extreme weather	4.12	0.045
Race (white)	92.4		Race (white)	93.4		Natural predators	3.84	0.051
Age ($\bar{x}$)	54.4	0.60	Age ($\bar{x}$)	55.3	0.30	Red imported fire ants	3.48	0.060
Rural background	48.5		Rural background	45.6		Diminished connectivity	3.15	0.057
Income			Income			Lack of suitable habitat	3.13	0.061
< $25 K	2.0		<$25 K	1.5		Wildlife diseases	3.11	0.045
$25K–$50 K	3.4		$25K–$50 K	4.8		Nonnative grasses	2.97	0.054
$50K–$75 K	10.7		$50K–$75 K	10.4		Shifting climate regimes	2.90	0.050
$75K–$100 K	17.7		$75K–$100 K	17.6		Overharvesting by hunters	2.24	0.059
$100K–$150 K	20.1		$100K–$150 K	23.0				
$150K–$250 K	20.7		$150K–$250 K	20.7				
> $250 K	25.4		>$250 K	22.0				

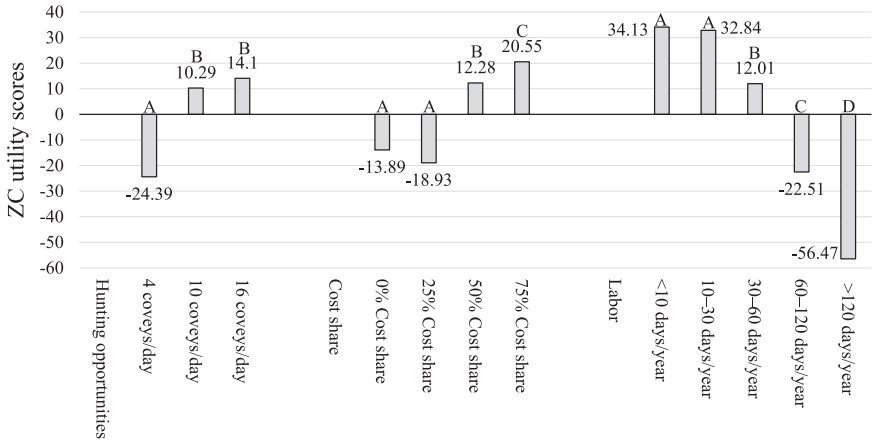

Figure 2. Zero-centered (ZC) utility scores by attribute (cost share, labor, and hunting opportunities) levels for Texas, USA, landowners surveyed in November 2017 regarding importance of attributes in making habitat restoration decisions for northern bobwhites. Different letters indicate significant differences between attribute levels.

The zero-centered utility scores, calculated for each attribute level, indicate that landowners had low preferences for fewer hunting opportunities and high labor, and high preferences for increased cost share and low labor (Fig. 2). The reported utility scores can be compared within an attribute (e.g., high labor and low labor), but are not directly comparable between attributes (e.g., low cost and low labor). We report respondent preferences in lieu of utility scores to aid interpretation. Among hunting opportunity levels, low hunting opportunities (4 coveys/day) was the least preferred, and the mid- and high hunting opportunities (10 coveys/day, 16 coveys/day) were not different (Fig. 2). The relationship appears to lack any thresholds; greater bobwhite hunting opportunities were increasingly preferred. Results for cost share and labor, however, supported our expectation of finding thresholds in attribute preferences. In the case of cost share, 0% cost share was slightly, but not significantly, more preferred than the 25% cost share. A positive relationship with cost share only emerged above 25%. Above that threshold, preference (50%, 75%) increased with higher cost share (Fig. 2). In the case of labor, bobwhite management could progressively require up to 30 days/year of labor without changes in preference, but rapidly dropped when management required >30 days/year. There was no difference between the 2 lowest labor attributes (<10 days/yr, 10–30 days/yr; Fig. 2). Preferences switched from positive to negative values between 30–60 days/year and 60–120 days/year (Fig. 2).

Latent Class Analysis

Results from the latent class analysis indicated 5 respondent segments representing landowner groups with different approaches to bobwhite habitat management. We labeled Segment 1 as "Disinterested Landowners" because this segment preferred low hunting opportunities, 0% cost share, and low labor (Table 3). This was the largest segment, accounting for 30.4% of landowners. We labeled Segment 2 as "Labor Minimizers" because this segment preferred low labor-attribute levels and demonstrated extremely low preference for high labor (Table 3). Preferences for increasing

Table 3. Texas, USA, landowner segment sizes and average utility scores for attribute levels based on latent class analysis. Texas landowners were surveyed in November 2017 regarding the importance of attributes in making habitat restoration decisions for northern bobwhites.

Segments	1	2	3	4	5
Segment label	Disinterested landowners	Labor minimizers	Opportunistic landowners	Pragmatic landowners	Hunting motivated landowners
Segment size	30.4%	18.7%	15.1%	15.8%	20.0%
Hunting opportunities					
4 coveys/day	30.94	−13.91	−18.30	−0.78	−105.94
10 coveys/day	−26.81	5.05	9.28	12.61	28.91
16 coveys/day	−4.13	8.85	9.02	−11.84	77.03
Cost share					
0%	96.90	−6.08	−116.92	28.23	−45.81
25%	−44.09	−7.99	−54.90	−6.41	−3.41
50%	−61.76	7.14	55.87	20.40	24.44
75%	8.95	6.93	115.94	−42.22	24.78
Labor					
<10 days/yr	47.17	75.34	−17.99	46.68	14.40
10–30 days/yr	17.22	60.51	−8.16	89.40	7.65
30–60 days/yr	−36.41	42.38	21.56	13.21	21.79
60–120 days/yr	1.42	8.56	−1.66	−33.58	−19.21
>120 days/yr	−29.41	−186.78	6.26	−115.71	−24.64

hunting opportunities and increasing cost-share percentages were both moderate among "Labor Minimizers" (Table 3). We labeled Segment 3 as "Opportunistic Landowners" because this segment retained moderate preference across all labor segments, and preferred more hunting opportunities and greater cost-share percentages (Table 3). Preference for cost-share attributes sharply changes with increasing cost-share percentages (Table 3). We labeled Segment 4 as "Pragmatic Landowners" because this segment had low preferences for idealistic attribute values. For example, conservation cost-sharing programs such as the Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) compensates for up to 50% of habitat management costs (TPWD 2007). We purposefully included a 75% cost-share option in our survey to entice landowners reluctant to increase labor and management for northern bobwhite. The "Pragmatic Landowners" segment demonstrated low preference for the 75% cost-share option (Table 3). This segment preferred the labor level of 10–30 day/year more than lower labor (<10 days/yr), and their preferences sharply declined at increased labor levels (Table 3). We labeled segment 5 as "Hunting Motivated Landowners" because this segment strongly preferred high hunting opportunities (Table 3). "Hunting Motivated Landowners" preferred higher cost-share percentages, but preferences for 50% cost share and 75% cost share were nearly identical (Table 3). This segment most preferred the median labor-attribute level (30–60 days/yr; Table 3).

We used segment identification and results from survey items related to bobwhite values, management objectives, and management actions to further explain differences among segments. Results of a one-way ANOVA and Tukey-HSD *post hoc* test suggest that "Hunting Motivated Landowners" value bobwhites as part of the landscape more than "Disinterested Landowners" ($F_{209} = 3.45$, $P = 0.009$; $q = 3.4$, $P = 0.007$). However, for these segments there was no difference (at $\alpha = 0.05$ level) between responses for the value of bobwhites as part of the ecosystem or their ability to provide wildlife-viewing opportunities. Among all segments, there were differences among responses to whether bobwhites are worth the effort to manage ($F_{368} = 7.92$, $P < 0.001$) and whether bobwhites compete with other more desirable wildlife for resources ($F_{366} = 9.01$, $P < 0.001$). "Disinterested Landowners" and "Pragmatic Landowners" were more likely to agree that bobwhites are not worth the effort to manage and compete with other wildlife, compared with the other 3 segments. We found differences in management objectives for land investment or development ($\chi^2_4 = 10.91$, $P = 0.028$), maintaining native grasslands ($\chi^2_4 = 10.84$, $P = 0.028$), and privacy ($\chi^2_4 = 10.05$, $P = 0.040$). The segments "Labor Minimizers" and "Opportunistic Landowners" more frequently reported land investment or development as an objective. The segment "Pragmatic Landowners" more frequently reported maintaining native grasslands as an objective, and the segment "Opportunistic Landowners" less frequently reported this objective. The segment "Disinterested Landowners" more frequently reported privacy as a management objective, and the segments "Labor Minimizers" and "Opportunistic Landowners" both less frequently reported privacy as an objective. We detected differences in reporting the management actions of brush management ($\chi^2_4 = 9.55$, $P = 0.049$) and prescribed fire ($\chi^2_4 = 18.79$, $P < 0.001$). "Disinterested Landowners" and "Pragmatic Landowners" less often reported brush management; the other 3 segments reported greater frequencies of brush management. "Hunting Motivated Landowners" more frequently reported prescribed fire management.

DISCUSSION

Labor attributes had the most and least preferred levels among respondents. This may be explained by landowner perceptions that increasing labor inputs are likely to negatively influence income generation and low labor inputs are likely to positively alter income generation. Most landowners in Texas with enough land to independently support bobwhite populations are engaged in agricultural production (e.g., farming, ranching, forestry; Burger 2002, Brennan 2007, Hernández et al. 2013). Previous research among Texas landowners engaged in farm and ranch diversification, which includes the reallocation and recombination of resources into unconventional crops–animals or non-agricultural enterprises (Ilbery 1991), suggests that these landowners most often diversify to generate additional income (Barbieri and Mahoney 2009). Managing for bobwhites could represent a form of farm or ranch diversification. However, high levels of labor for bobwhite habitat management could represent lost, rather than increased, income. This potential reallocation of labor away from a landowner's primary means of income generation can explain the extremely low preference for high labor requirements. On the opposite end, low labor levels were the most preferred among all attributes. Therefore, minimizing labor requirements could help develop bobwhite habitat management into a viable land diversification strategy in the minds of landowners.

Cost-share and hunting opportunity preferences were not as extreme as labor preferences because differences in cost-share percentages and hunting opportunities likely represent smaller potential gains or losses compared with labor inputs. Unlike labor, which could potentially divert resources away from income-generating management, cost share only applies to management for bobwhite habitat. Landowners can determine how often they manage for bobwhite habitat and what percent of their land will be managed for bobwhite habitat, regardless of cost-share percent. For cost-share programs such as EQIP, management options are relatively flexible, including prescribed grazing, prescribed fire, other brush management techniques, and native grass reseeding (Burger et al. 2006). The bobwhite hunting opportunities attribute may have the lowest variance between attribute levels because landowners have a relatively accurate and nuanced understanding of hunting opportunities as having the lowest direct economic effect and being the least controllable attribute. Although bobwhite hunting can generate lease income comparable to ranching revenue in some parts

of Texas, this is not typical for most landowners in the state (Rollins 2002, Conner 2007, Horn 2015). Further, some landowners may perceive greater hunting opportunities as a noneconomic incentive. For some, greater bobwhite populations may signify more hunting opportunities for themselves and friends and family, rather than a potential income generator (Horn 2015). Finally, some landowners value bobwhites for their cultural (e.g., connection to childhood and family), aesthetic (e.g., enjoying seeing and listening to them), and ecological reasons (Horn 2015). These landowners may therefore not place high utility on greater hunting opportunities compared with potential economic interests, labor, and cost share. Further, landowners who are interested in the economic value of bobwhites may be concerned regarding marked fluctuations in bobwhite abundance that are largely out of their control. For example, bobwhite abundance fluctuates markedly among years due to variation in precipitation in semiarid regions, and can be substantially decreased by extreme weather events (Bridges et al. 2001, Hernández et al. 2005, Hernández and Peterson 2007). Variability of bobwhite populations, along with the multiyear management needed to develop bobwhite habitat likely positions bobwhite populations, and thereby hunting opportunities, as an attribute that is both uncertain and risky.

Thresholds identified for labor and cost-share percentage suggest that noneconomic values influence preferences for bobwhite habitat management. The increased preference for 0% cost share compared with a 25% cost share, among "Disinterested Landowners" and "Pragmatic Landowners," can likely be explained by preferences to remain independent from government agreements. Previous research regarding barriers limiting private-lands conservation agreements indicates that landowners can be reluctant to enter agreements with government agencies because many programs are perceived as inflexible or as restricting a landowner's independence (Ramsdell et al. 2016). The aforementioned landowner segments likely preferred the 0% cost-share attribute level because they attributed more value to avoiding a conservation agreement, than gaining 25% cost share for management. A 25% cost share requires a conservation agreement and covers less management costs than current cost-share programs such as CRP (USDA 2018). This also helps explain why respondents preferred the 50% and 75% cost-share agreements. Respondents were likely aware that 50% cost share is the greatest share for programs such as CRP. Surprisingly, preference for a 75% cost share was not greater than the 50% cost share among "Labor Minimizers" or "Hunting Motivated Landowners," and sharply declined for "Pragmatic Landowners." There are 2 likely explanations for these facts. First, more landowners from these segments, especially "Pragmatic Landowners," may be aware of the 50% cap on cost-share programs and rejected the 75% attribute as unrealistic. This type of response to a survey option has been described as a protest response (Boyle 2017). Second, the difference in value between a 50% cost share and a 75% cost share may be marginal from a landowner's perspective, especially if time and labor required to conduct habitat management are limiting factors. This could mean that programs aiming to increase conservation on private lands may not see better results if they offered slightly greater cost shares for habitat management.

Our latent class analysis characterizes unique landowner segments, and provides opportunities to develop strategic outreach and marketing materials for persuadable landowners. Latent class analysis has been used for studies identifying distinct population segments among anglers, hunters, and landowners (Provencher and Moore 2006, Ward et al. 2008, Sorice et al. 2011). In a study of preferences for endangered species management on working lands, Sorice et al. (2011) identified a segment of landowners that would likely be more willing to participate in endangered species habitat management if they received technical assistance and were engaged in cost-share programs. Similarly, we identified 2 landowner segments that can be considered what Cox (2012) referred to as "persuadables," or individuals who are conducting little if any bobwhite habitat management, but could be persuaded to actively engage in bobwhite habitat management given the right motivation. "Opportunistic Landowners" would most likely be motivated to manage for bobwhite habitat if they perceived costs to be low and economic benefits high. Describing bobwhite habitat management as a viable form of land diversification may be well-received by landowners in this segment (Barbieri and Mahoney 2009, Huang 2009). Economic analysis of bobwhite and timber management in the southeastern United States suggests that developing bobwhite habitat can successfully increase economic returns on private lands that produce timber, especially on lands with lower site quality (Huang 2009). "Pragmatic Landowners" would likely be motivated to manage for bobwhite habitat if labor inputs were kept low. These landowners may be persuaded to manage for bobwhite habitat if they receive technical advice or assistance for management. Outreach materials that outline the amount and timing of labor to manage for bobwhite habitat, and ways to minimize these inputs may help landowners concerned about labor needs.

MANAGEMENT IMPLICATIONS

Our results can be used to help organizations managing bobwhite habitat-restoration programs, such as the Oaks and Prairies Joint Venture's (OPJV) Grassland Restoration Incentive Program, develop and refine market-based conservation strategies and further communicate their strategic plans (OPJV 2015). Given half of landowners were unsure whether their neighbors managed for bobwhites, awareness campaigns may establish normative pressure to engage in management. Efforts to engage all landowners would benefit from providing and clearly marketing programs with: cost shares $\geq$50%, labor inputs at $\leq$30 days annually, and likely coveys flushed per hunting day >4 or approaching 10. We recognize such programs may be difficult to implement given the stochasticity in quail populations, but our results suggest ensuring low labor inputs are more important than ensuring high bobwhite abundance. To help frame

bobwhite habitat management as a viable form of land diversification, labor intensity and frequency should be included when discussing bobwhite habitat with landowners. The results of our latent class analysis suggest "Opportunistic" and "Pragmatic" landowners are persuadables who may be convinced to begin bobwhite habitat management by strategic marketing and effective communication. Efforts to engage opportunistic landowners should emphasize the lowered costs of management under programs such as EQIP or CRP, whereas efforts to engage pragmatic landowners should focus on maintaining low labor inputs.

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