Rangeland Ecol Manage 66:529–538 | September 2013 | DOI: 10.2111/REM-D-12-00174.1

Contrasting Preference for Grassland Landscapes Among Population Groups in the Central and Southern Great Plains

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Abstract

Recent opposition to the rangeland management paradigm of achieving uniform, moderate grazing across entire landscapes has emerged because heterogeneity is recognized as the foundation of biodiversity, ecosystem resilience, and multifunctionality of agricultural landscapes. Agriculture production goals appear to drive the traditional rangeland management focus on homogeneity and uniformity. To determine if preference for homogeneity is a broadly applicable social construct or one limited to agricultural producers, we determined preferences for heterogeneous grassland landscapes expressed by three study populations—managers of working lands (ranchers), natural resource professionals (grassland/rangeland specialists), and the general population living in rangeland regions within the US Great Plains. We distributed surveys that included photographs of landscapes and patterned images to assess preference. Preference for heterogeneous landscapes among ranchers, natural resource professionals, and the general population in our study area were generally consistent with the central paradigm of managing rangeland for homogeneity. However, we discovered that people, across geographic location and population group, clearly prefer heterogeneous patterned images to homogeneous patterned images. This suggests that preference for homogeneity is acquired.

Key Words: biodiversity, conservation of pattern and process, heterogeneity, landscapes patch burning, pyric herbivory, vegetation structure

INTRODUCTION

The central paradigm for rangeland management in the twentieth century is directed toward achieving uniform, moderate grazing across entire landscapes (Fuhlendorf and Engle 2001). Recent opposition to this paradigm of uniformity has emerged in multiple disciplines through the critical concepts of heterogeneity, biodiversity, and variability. Ecologists have come to recognize heterogeneity as the foundation of biodiversity, ecosystem resilience, and multifunctionality of agricultural landscapes (Kolasa and Pickett 1991; Ludwig and Tongway 1995; Christensen 1997; Ostfeld et al. 1997; Wiens 1997). Agriculture production goals, more so than conservation goals, appear to drive the traditional focus on homogeneity and uniformity (Holechek et al. 2004; Fuhlendorf et al. 2012). Thus, it is unclear whether a preference for homogeneity is a broadly applicable social construct or one limited to agricultural producers. A new paradigm that seeks to restore processes that promote biodiversity by managing for heterogeneity (e.g., pyric herbivory) has arisen in rangeland management (Fuhlendorf et al. 2012). Similarly, recent research into environmental and landscape perception focuses on conserving biodiversity and protecting the many services provided by diversity-rich ecosystems (Williams and Cary 2002; Gobster et al. 2007; Lindemann-Matthies et al. 2010).

Managing for biodiversity and multifunctionality on private lands often creates conflict when agricultural production is the primary rangeland management goal. This is especially true in Great Plains states where most land is privately owned. Alternative, nontraditional management practices can sometimes resolve the conflict, but land managers must accept and adopt these practices and must have the support of the local community. The successful introduction of alternative land management practices that foster heterogeneity might require a greater understanding of cultural factors and social constructs affecting management practice decision making. Understanding how people perceive and experience landscapes can be critical to achieving practitioner adoption and public support for heterogeneity.

Ranchers might prefer homogeneous grassland more so than the other population groups (i.e., general population and natural resource professionals) because ranchers likely associate homogeneity with greater agricultural production. Best management practices, i.e., broadcast herbicide application, uniform grazing distribution, and planting of introduced forage grasses, have promoted uniform, moderate grazing across the landscape. Livestock performance has been the overarching goal, despite other valuable services grasslands can provide (Fuhlendorf and Engle 2001.) Natural resource professionals might have learned to associate heterogeneous habitats with diverse populations of grassland wildlife. Preferences for diverse, wildlife-friendly landscapes can be acquired through knowledge and experience (Bourassa 1991; Strumse 1996; Gobster et al. 2007; Tempesta 2010).

Research was funded by USDA–AFRI Managed Ecosystems #2010-85101-20457 and by the Oklahoma Agricultural Experiment Station.

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Manuscript received 25 November 2012; manuscript accepted 16 April 2013.

Similarly, preference for homogenous landscapes might be learned because people generally prefer visual diversity (Kaplan and Kaplan 1989; Kaplan et al. 1989; Herzog and Bosley 1992; Lindemann-Matthies et al. 2010). Therefore, we expect all study groups to prefer visually diverse, heterogeneous images to visually uniform images when the images are not clearly associated with landscapes. Moreover, we expected that all study groups (the general population, ranchers, and natural resource professionals) would express an equal level of preference for heterogeneous images.

Our overarching objective was to determine preferences for heterogeneous grassland landscapes expressed by three study populations—managers of working lands (ranchers), natural resource professionals (grassland/rangeland specialists), and the general population living in rangeland regions within the US Great Plains. We predicted ranchers prefer homogeneous landscapes more than the other study populations, and the general population prefer landscapes that are more heterogeneous than do ranchers because preferences of the general population are not dictated by agricultural production. Preferences of rangeland/grassland specialists might be influenced by academic training or position responsibilities associated with production agriculture, and these specialists more likely associate with the ranching culture. Therefore, we predicted that preferences of rangeland/grassland specialists would more closely align with ranchers than with the general population. We also predicted that all population subgroups prefer heterogeneously patterned images to homogeneously patterned images, and this preference is equal among population subgroups.

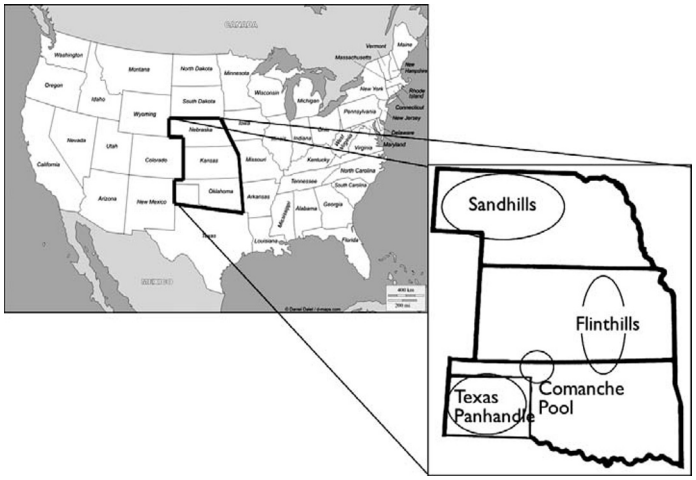

Figure 1. Map of the central-southern Great Plains of the United States with spheres indicating the four study areas that represent major ranching areas within the region. The four study areas, from north to south, are the Nebraska Sandhills, the Flinthills of Kansas and Oklahoma, the Comanche Pool of southwest Kansas and northwest Oklahoma, and the Texas Panhandle.

METHODS

Study Area and Survey Populations

The study area encompassed the Texas Panhandle, Oklahoma, Kansas, and Nebraska. Grasslands in this portion of the Great Plains states are commonly managed for homogeneity and uniformity, and they vary in extent of fragmentation, ownership size, reliance on prescribed burning, and vegetation type (shortgrass to tallgrass prairie). These characteristics made the area well-suited for examining grassland preferences. The study focused on well-known ranching areas (shown in Fig. 1)—the Texas Panhandle north of the Red River; the Comanche Pool, in northwest Oklahoma and south central Kansas; Osage County in Oklahoma and the Kansas Flint Hills; the Nebraska Sandhills and other ranching counties in Nebraska as well (hereafter referred to as the Nebraska Sandhills). We surveyed three populations in the study area: ranchers and land managers in the specific ranching areas; and district-level grassland and rangeland specialists employed by the USDA–Natural Resources Conservation Service (NRCS); and the general population throughout each state.

County agriculture educators with the Cooperative Extension Service in Nebraska, Kansas, and Oklahoma and local leaders in Texas identified ranchers from their records, and mailed the surveys to protect the confidentiality of their constituents. State distributions were Nebraska, 92; Kansas, 18; Oklahoma, 89; and Texas, 64. All addresses were assumed valid. Ranchers received only one mailing because 1) ranchers in Texas knew who was sending the survey, 2) agriculture educators knew the survey recipients, and 3) the mail piece came from the local county Extension office. Contact information for NRCS Grassland and Rangeland specialists was obtained online through information posted on the NRCS website (NRCS 2011), and we contacted all on the list. State distributions were Nebraska, 10; Kansas, 36; Oklahoma, 51; and Texas, 10. To survey the general population, we purchased a list of 5 003 mailing addresses, which was calculated as necessary to achieve a 35% completed response rate from the total number of households across the four states. A postal service check of the mailing list determined that 208 addresses were not valid, so we distributed 4 795 survey instruments to valid addresses in the study areas in proportion to the population in each state. State distributions, shown in Figure 1, were Texas 4.5% (225 surveys), Nebraska 20.9% (1 046 surveys), Kansas 31.7% (1 583 surveys), and Oklahoma 42.9% (2 147 surveys).

We distributed the survey by postal mail to the general population, grassland/rangeland specialists, and rancher study populations in May and June 2011. The response rate of returned surveys was adjusted to reflect completed surveys returned. Ranchers returned 264 completed surveys (28% adjusted response rate). The majority of ranchers (86%) were male, 86% were older than age 50, 98% had a minimum of high school education, and 21% held advanced degrees. Adjusted response rate and demographic characteristics of the respondents in rancher populations were consistent with those of other surveys in the Great Plains areas (Case and Associates 2006; Cross et al. 2011) and with census data for the study areas (USDA ERS 2007). The general population returned 1 037 completed surveys (22% adjusted response rate); 63% were male, 73% were age 50 or older, 97% had a minimum of high school education, and 17 percent held advanced degrees. A majority of respondents of ranchers and general population (49% of ranchers and 54% of general population) had resided

in their current residence 10 yr or more, (37% of ranchers and 25% or general population have resided at their current residence all of their life). The grassland/rangeland specialists returned 107 (56% adjusted response rate). This group was 73% male with 39% aged 50 or older, 45% aged 31 to 49, and 12% younger than 30.

The Survey Instrument

The survey gathered data about preferences of the three population groups (the general population, ranchers, and natural resource professionals) for landscape heterogeneity in grasslands. The survey included a visual element (photographs) as well as written questions to assess landscape preference (e.g., Trent et al. 1987; Kaplan and Kaplan 1989; Hunziker and Kenast 1999; Daniel, 2001).

We used Dillman's (2000) multiple-contact method, including 1) notification letter mailed on day one of the survey, 2) survey questionnaire on day 13 of the survey, 3) a reminder postcard on day 21, and 4) replacement questionnaire to nonrespondents on day 33. The final contact was made by telephone to nonrespondents with landline telephones beginning on day 40 (June 27). Nonresponders for whom landline telephone numbers were available were called and asked to answer an abbreviated set of questions. Some respondents asked if they could return their survey; callers responded yes, thanked the respondent, and ended the call. Data from those surveys were added to the database of returned surveys. For unanswered calls, repeat calls were made at different times of day and different days of the week from that of the initial telephone call. All telephone numbers of nonrespondents were dialed at least once. Oklahoma State University Office of Research Assurance reviewed and accepted the proposed survey methodology and instruments to assure protection of human subjects (IRB Application No. 1117). The survey questions were tested for clarity in a pilot test and revised prior to distribution of the survey.

Visual Element. We collected a variety of grassland landscape photographs that depicted a range of homogeneity and heterogeneity on fine and coarse scales. We eliminated photographs that would not work for printing purposes. We manipulated the photographs to minimize landscape characteristics, other than heterogeneity, to which participants might respond by digitally removing trees and anthropogenic elements (fences, vehicle tracks, buildings, etc.), and livestock (e.g., Kaplan et al. 1989; Lindemann-Matthies et al. 2010; Fig. 2). Photographs were converted to black and white to eliminate color as a factor influencing preference (Hunziker and Kenast 1999). The same sky and horizon line were used in all photographs to eliminate sky and skyline as factors influencing preference. We analyzed each photograph using quantitative pattern analysis, which measures unclassified landscape patterns by measuring areas of gray tones (Hunziker and Kenast 1999). Pattern of gray-scale patches in the entire image of each photograph was analyzed for number of patches, total edge, contagion, perimeter to area fractal dimension, and interspersion/ juxtaposition index using FragStats 3.3 (McGarigal et al. 2002).

Using principal component analysis on the pattern metrics, total edge was identified as the principal component, which allowed us to order the images on a pattern scale with total edge as the proxy for heterogeneity (Gauch 1982; SAS Institute 2008). Therfore, the pattern scale ranged from relatively homogeneous (low total edge) to relatively heterogeneous (high total edge). After running the metrics on the selection of photographs, we selected eight photographs that represented a range, from low to high, in edge (heterogeneity) values. We ranked the eight photographs by relative hetergeneity from 1 to 8—least to most edge. When photographs were numerically close, we visually selected one.

We also manipulated three of the selected photographs, those ranked 1, 4, and 7 in relative heterogeneity, to create patterned images (Fig. 3) showing low, moderate, and high heterogeneity. The patterned images were used to evaluate respondent general preference for homogeneity/heterogeneity without any contextual linkage. The photographs were converted from desaturated color to a 10-unit gray scale in an ASCII format to facilitate analysis with FragStats software (McGarigal et al. 2002).

The photographs were displayed in a random order to avoid presenting a homogeneous to heterogeneous gradient (Lindemann-Matthies et al. 2010). Participants were asked to rate their level of preference for each photograph and patterned image without identifying the quality in the photograph or image that we were assessing and without explaining differences among the photographs and images. We took this approach to avoid introducing value-laden terms (e.g., uniformity, heterogeneity) that would influence preference, and to avoid influencing participant preferences by making them aware of features in the photograph they might not notice on their own. Participants were asked to rate each of eight photographs and the three patterned images on a Likert response scale ranging from zero (no opinion), one (dislike) to five (like very much) with three as "neither like nor dislike."

Data Analysis. The average preference score was calculated for each photograph as the product of the frequency of each preference score and the preference score value (1, 2, 3, 4, or 5) divided by the total number of observations other than 0 (no opinion) as in Equation 1:

$$\text{Preference Score} = \text{Frequency} \times \text{Score Value}/n \qquad [1]$$

where score value corresponds to preference categories 1, 2, 3, 4, or 5, frequency is the number of observations per score value, and n is the total number of observations for that photograph.

We conducted a Chi-square (χ^2)analysis of preference scores using the CATMOD procedure within SAS (SAS Institute 2008). We examined the data for the three-way interaction (population group by state by photograph). Because the three-way interaction was significant ($P=0.0021$), we used the Contrast statement in CATMOD to test for differences in preference among populations within each of the eight landscape photographs. Level of significance was at 0.05.

To present preferences of photographs and patterned images more clearly, we transformed the preference scale from 1 to 5 with 3 as the neutral value to a scale of –2 to +2, with 0 as the neutral value. We similarly compared preference scores for the pattern abstract images and conducted a similar χ^2 analysis.

Figure 2. The eight, 10-unit grayscale images (photographs) used in the survey. Photographs are numbered according to their heterogeneity rank, which corresponds to their Fragstat total edge measurement.

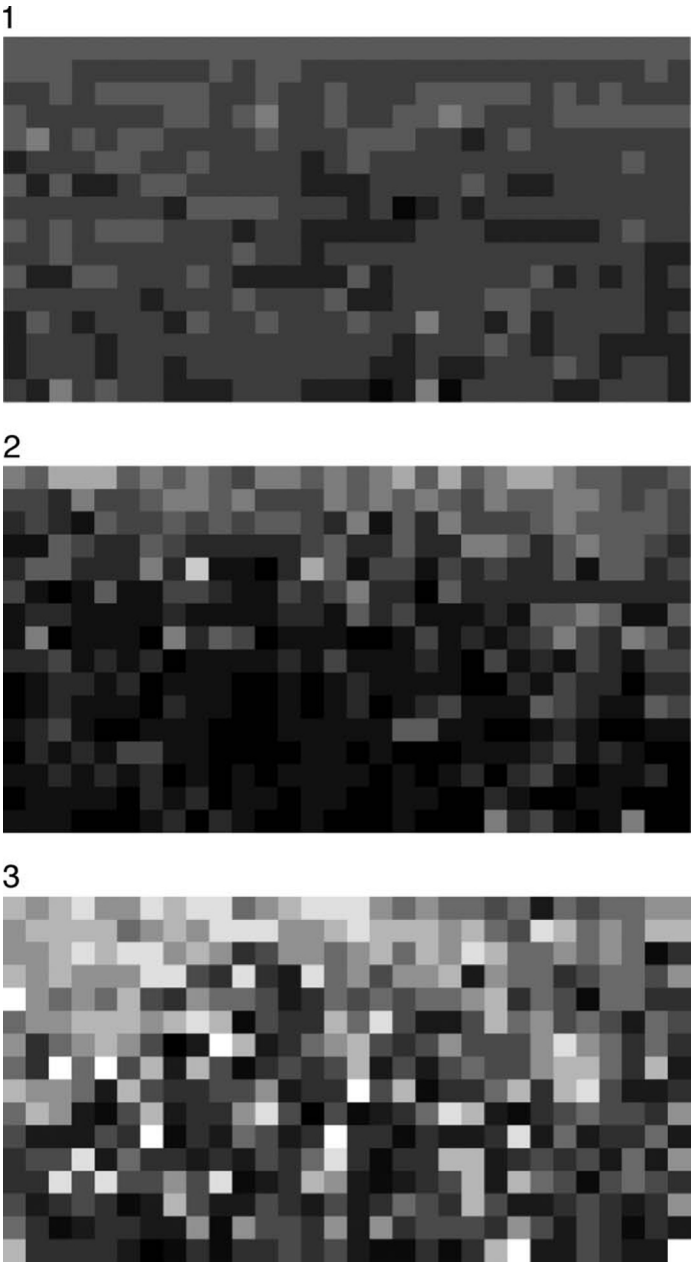

Figure 3. The three aggregate, patterned images used in the survey: Image 1, low heterogeneity (most homogeneous); Image 2, medium heterogeneity; Image 3, high heterogeneity. Three abstract pattern images were created from three of the photographs to assess preference for pattern outside the context of landscape. The photographs were converted from color to a 10-unit gray scale.

RESULTS

Preference for Landscape Heterogeneity

We found a significant ($P < 0.002$) three-way interaction of state, population group, and photograph, and there was a two-way (state-by-population group) interaction ($P < 0.05$) for four of the eight photographs (photographs 4, 5, 7, and 8). Therefore, the results are presented for each photograph by population group and state (Fig. 4). Preference scores of the general population for the more heterogenous landscapes (photographs ranked 4–8) were generally markedly higher than preference scores of the other population groups, except all groups scored the midrange hetergeneous landscape (photograph 5) as "like" (score of > 0; Fig. 4). Two of the three most heterogeneous landscapes (i.e., photographs ranked 6 and 8) stand out as being disliked more by grassland specialists and ranchers than the general population, but this difference was also striking for photograph 4, a midrange heterogeneous landscape. The photograph ranked 7, the second most heterogeneous landscape, received generally neutral scores from grassland specialists and ranchers. A moderately heterogeneous landscape (photograph ranked 5), was the only landscape with preference scoring consistently above 0 by all study populations across all states. Differences among the study populations tended to be greatest in Texas (Table 1; Fig. 4).

Rancher preference scores for homogeneous landscapes (photographs ranked 1–4) generally differed little from the scores of the other population groups, and were in most cases close to the neutral score of 0. However, rancher lack of preference for homogeneous landscapes was inconsistent. A clear, region-wide "like" score (score > 0) among ranchers for the relatively homogeneous landscape presented in the photograph ranked 3 contrasts with a region-wide "dislike" score (score < 0) of the landscape in the photograph ranked 4.

Rancher preference scores of the three most heterogeneous landscapes (photographs ranked 6, 7, and 8) were always lower ($P < 0.0001$) than the general population. With only a few exceptions, rancher scores were remarkably similar to grassland specialists. However, on four mostly homogenous landscapes (photographs 1, 2, 3, and 5), preferences of grassland specialists did not align more closely with ranchers than with the general population. This can be seen, for example, in the preferences for the landscape in photograph 2. There was as much as 1.0 preference-score unit difference between grassland specialists and ranchers (in Oklahoma) as compared to no more than 0.2 preference-score unit difference between preferences of grassland specialists and ranchers on photograph 8 (also in Oklahoma). Moreover, preference scores of grassland specialist and ranchers alike were lower than the general population on the three most heterogeneous photos (photos 6, 7, and 8).

General Perception of Heterogeneity

Unlike preferences expressed for photographs of landscapes, there was no three-way interaction among image, population group, and state for preference of patterned images ($P < 0.085$). However, all population groups preferred heterogeneously patterned images to homogeneously patterned images. Moreover, preference scores for images interacted ($P < 0.011$) with population group. The general population exhibited the greatest difference in preference (> 1.0 preference unit) from low to high image heterogeneity, and ranchers exhibited the least difference in preference from low to high heterogeneity (Fig. 5). Contrary to our prediction, preference scores differed among population groups. Preferences of grassland specialists and ranchers differed for low and medium heterogeneity images, and the general population and ranchers differed among high heterogeneity images (Table 2), Preference

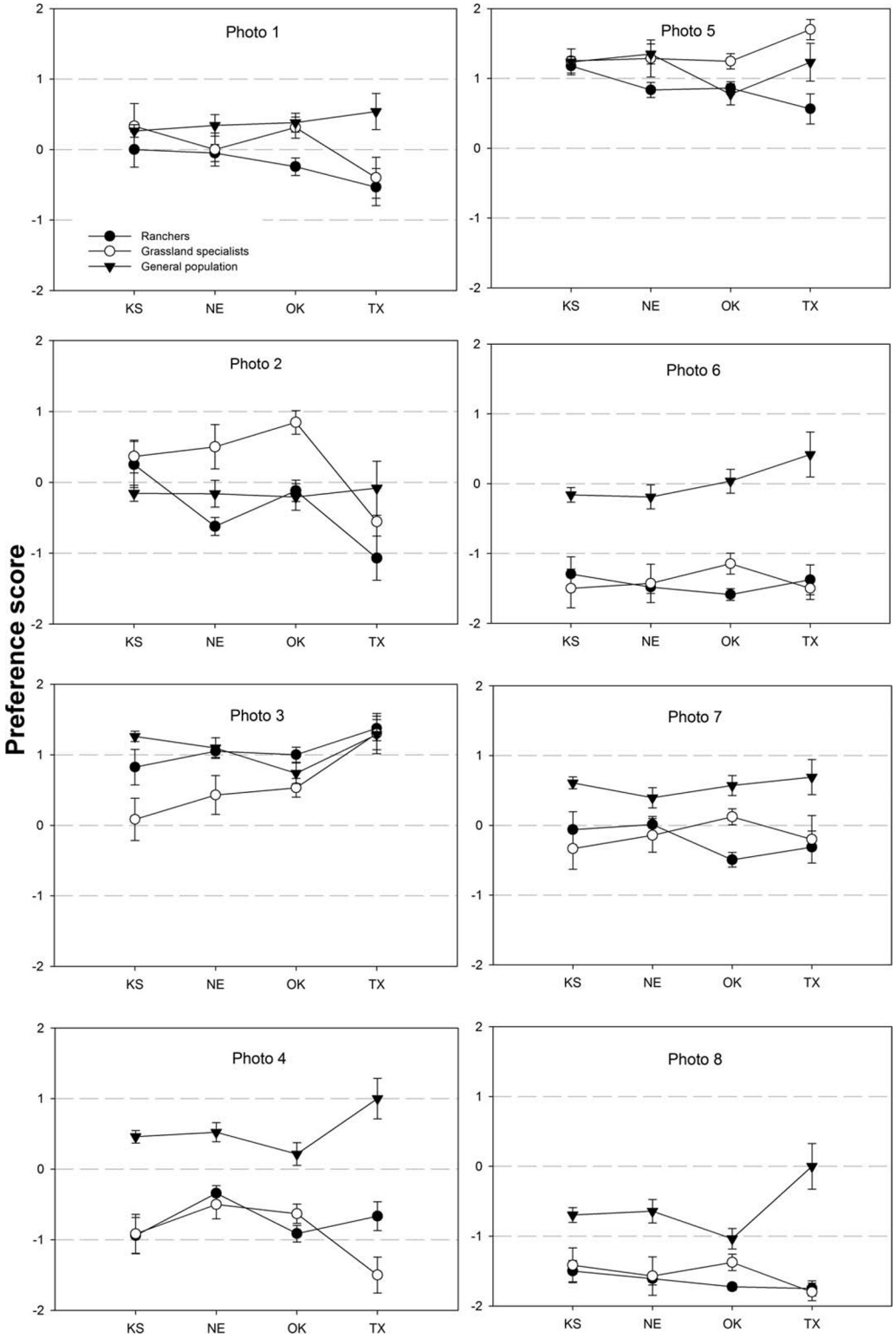

Figure 4. Preference (means and standard error bars) of the photographs in Figure 2 of three population groups across four states. Preference rating scale: Dislike (–2), Somewhat dislike (–1), Neither like nor dislike (0), Somewhat like (+1), Like very much (+2)

scores did not differ among states ($P < 0.7867$) nor did state interact with image ($P < 0.9752$) or population group ($P < 0.4474$).

Contrary to our prediction, ranchers did not clearly prefer homogeneous landscapes, yet ranchers clearly disliked several heterogeneous landscapes. As we predicted, the general population preferred several of the more heterogenous landscapes than did ranchers, and preferences of landscapes by grassland specialists generally closely aligned with rancher preferences. However, we found exceptions to these for both homogeneous landscapes and heterogeneous landscapes. Therefore, some unknown factor or factors other than

Table 1. Contrasts ($P > \chi^2$) computed by PROC CATMOD of paired comparisons of preference scores of eight landscapes shown in Figure 2 by grassland specialists (GLS), members of the general population (GP), and ranchers (RAN). Values in bold are $P < 0.05$.

		Photos							
State	Contrast	1	2	3	4	5	6	7	8
Kansas	GLS vs. GP	0.5598	0.2736	**0.0034**	**0.0277**	0.8110	**0.0119**	0.0628	0.2306
	GLS vs. RAN	0.6611	**0.0435**	**0.0001**	**< 0.0001**	0.8724	**< 0.0001**	**0.0002**	**< 0.0001**
	GP vs. RAN	0.3190	0.6758	0.6068	0.0154	0.6737	0.1064	0.5040	**0.0299**
Nebraska	GLS vs. GP	0.5675	**0.0072**	**0.0254**	**0.0077**	0.4858	**0.0425**	**0.1798**	0.1263
	GLS vs. RAN	0.0697	0.6892	0.0821	**< 0.0001**	0.1521	**< 0.0001**	**0.0190**	**< 0.0001**
	GP vs. RAN	0.2317	**0.0004**	0.1054	**0.0315**	**0.0088**	**0.0003**	0.5307	**0.0061**
Oklahoma	GLS vs. GP	0.1677	**< 0.0001**	**0.0353**	0.0947	**0.0024**	**0.0376**	0.5632	0.9658
	GLS vs. RAN	**0.0370**	**0.0091**	0.8661	**< 0.0001**	0.0925	**< 0.0001**	**<0.0001**	**0.0014**
	GP vs. RAN	**0.0002**	**0.0253**	**0.0118**	**< 0.0001**	0.2570	**< 0.0001**	**<0.0001**	**< 0.0001**
Texas	GLS vs. GP	0.2414	0.9674	0.9235	**< 0.0001**	**0.0004**	**< 0.0001**	0.3060	**< 0.0001**
	GLS vs. RAN	**0.0019**	0.1243	0.8480	**< 0.0001**	0.7397	**< 0.0001**	**0.0036**	**< 0.0001**
	GP vs. RAN	0.0661	0.0838	0.7411	0.1368	**0.0006**	**0.0029**	0.0735	**< 0.0001**

heterogeneity also influenced preference for the images of grassland landscapes used in this study.

DISCUSSION

Preference for heterogeneous landscapes among ranchers, natural resource professionals, and the general population in our study area were generally consistent with the central paradigm of managing rangeland for homogeneity. However, we discovered that people, across geographic location and population group, clearly prefer heterogeneous patterned images to homogeneous patterned images. Landscape preference research has shown that people generally prefer visual complexity (Kaplan and Kaplan 1989; Kaplan et al. 1989; Herzog and Bosley 1992; Lindemann-Matthies et al. 2010), and this preference extends to landscapes through visual complexity of species richness (Lindemann-Matthies et al. 2010). Our results of preference for landscapes portrayed in the photographs suggest that ranchers and grassland specialists acquire a dislike of heterogeneous landscapes that runs counter to their general preference for visual heterogeneity. Whereas a likely shared culture between ranchers and grassland specialists might explain a correspondence of preference, it does not indicate the strength or weakness of correspondence (Kaplan and Kaplan 1989). This aligns with the idea that preferences are formed by an individual's own subjective feelings and judgments (Lothian 1999), which in turn are based on a variety of factors, i.e., social groups, experience, urban versus rural, education, occupation, imagination, and environmental attitude (Gonzalez-Bernaldez and Parra 1979; Dearden 1984; Lindemann-Matthies et al. 2010).

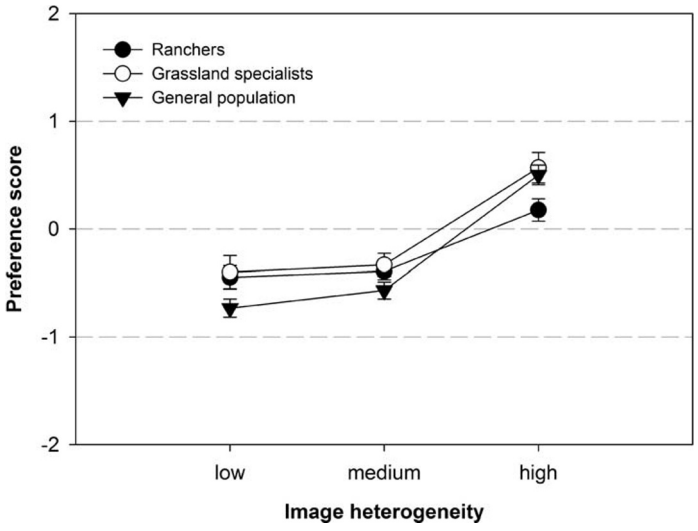

Figure 5. Preference scores (means and standard error bars) of patterned images among ranchers, grassland specialists, and the general population. Preference rating scale: Dislike (–2), Somewhat dislike (–1), Neither like nor dislike (0), Somewhat like (+1), Like very much (+2)

The subjective nature of preference allows wide variability in landscape preference, which we found in this study. Within this variability, we found evidence that ranchers and grassland specialists preferences are more complex than simply falling neatly under the homogeneity management paradigm of rangeland management. In particular, both ranchers and grassland specialists tended to dislike highly heterogeneous landscapes, while expressing neutral preference for homogenous landscapes. Because preference among ranchers and grassland specialists varied along the heterogeneity gradient (i.e., from photograph 1 to photograph 8), some other factor or factors beyond heterogeneity shapes preferences of ranchers and grassland specialists. This other factor might be the presence of forbs.

Table 2. Contrasts ($P > \chi^2$) computed by PROC CATMOD of paired comparisons of preference scores of three patterned images by ranchers, grassland specialists (GLS), and the general population (GP). Values in bold are $P < 0.05$.

	Low heterogeneity	Medium heterogeneity	High heterogeneity
GLS vs. GP	0.2543	0.2191	0.1433
GLS vs. Ranchers	**0.0140**	**0.0436**	0.3126
GP vs. Ranchers	0.3950	0.5633	**0.0071**

In keeping with the notion that the traditional focus on homogeneity is driven by agriculture production goals (Fuhlendorf et al. 2012), we expected both ranchers and grassland specialists to highly prefer homogeneous landscapes and to prefer homogenous landscapes more than the general population. Instead, preference for the two most homogenous landscapes was generally near neutral (neither like nor dislike), which supports the idea that preference for homogeneity driven by agriculture production goals is a broad social construct. Moreover, finding that ranchers failed to prefer highly homogenous landscapes out of context of their ranch suggests ranchers might be receptive to management practices that promote heterogeneity. Results of a focus group of ranchers from the Flint Hills of Kansas and the Osage Hills of Oklahoma indicate that ranchers clearly equate homogeneous, not heterogeneous, landscapes with utility (unpublished transcript of the focus group, September 2010). A small amount of forest-related literature discusses the difference between preferences for aesthetic attributes and for management-associated attributes (Sheppard et al. 2001; Ribe 2002; Shelby et al. 2005; Carvalho-Ribeiro and Lovett 2011). Ranchers and grassland specialists holding utilitarian land use attitudes might determine preference of landscapes differently than individuals lacking a utilitarian attitude. For example, more homogeneous landscapes indicative of grazing might be more preferred because their utilitarian value is recognized (Ribe 2002).

Preference scores of the general population were greater than the other two population groups on photographs of most of the more heterogeneous landscapes (photographs 4, 6, 7, and 8). Familiarity and experience are among the factors that account for preference, so where a person lives or has visited, or what a person has learned formally or informally, all contribute to the formation of their individual preferences (Kaplan and Kaplan 1989; Gobster 1999). Therefore, these results are somewhat surprising given that the general population resides in an agricultural region and 57% had some knowledge or experience with ranching (data not shown), but most people in the general population likely lack range management education that draws on the traditional production paradigm (Fuhlendorf et al. 2012).

Although preference within a population group across states differed, no clear pattern emerged. The general population of Texas scored three photographs of landscapes higher than the general population from other states. Lacking an obvious explanation leaves open an opportunity for further investigation of socio-cultural effects that might shape rangeland management decisions even within the Great Plains. The most highly preferred landscapes were midrange in the array of homogeneity-to-heterogeneity (photographs 3 and 5). The preference by all groups for these two photographs suggests that survey participants might have responded to the lack of forbs in these two images. An aversion to forbs might reflect preferences tied to the traditional agricultural production/management paradigm. Ranchers preferred ("liked") two low- and moderate-heterogeneity landscapes (photographs 3 and 5) that displayed low abundance of forbs, and ranchers disliked a moderate-heterogeneity landscape (photograph 4), which had high forb abundance. Aversion to forbs might reflect a conservation paradigm discovered elsewhere in the region in which cattle producers equate weed control with conservation management (Morton et al. 2010). Herbicides are widely used on grasslands in the region to control forbs (Fuhlendorf et al. 2009) and elsewhere on US rangeland (Bussan and Dyer 1999). All three population groups also might prefer landscapes they equate with agricultural productivity, that is, landscapes with abundant grass and few forbs. Photographs 3 and 5, which were "liked" by all three population groups, are landscapes with an abundant standing crop of grass and few forbs.

Our best explanation of why members of the general population in three states disliked the most heterogeneous landscape is that they assimilated the agricultural production paradigm. Photograph 8 is clearly heterogeneous and also contains a large number of forbs and short grass that might appear as bare ground. The general population preference appears to arise from an understanding of the important economic role grasslands play in the regions.

Preferences for landscapes among Texans were sometimes markedly different from other population groups and the Texas general population differed markedly from ranchers and grassland specialists. This is especially true of the landscape in photograph 4, which contains an abundant population of common broomweed (*Amphiachyris dracunculoides* [DC.] Nutt.). This calls into question the success of wildlife education programs targeted at Texas land managers that promote the habitat value of common broomweed and other forbs for avifauna including upland game birds (Rollins 2003).

It is possible that respondents found it difficult to appraise the images because of the lack of explanatory information provided. None of the populations highly preferred any of the patterned images. According to written comments on survey forms, participants expressed more frustration with the patterned images than with the photographs. The photographs also frustrated many respondents because they could not see adequate detail on which to evaluate the landscape. In other studies using photographs of landscapes, landscape elements (e.g., density and height of trees, the proportion of land in cultivation) clearly differ among landscapes (Lindemann-Matthies et al. 2010; Carvalho-Ribeiro and Lovett 2011). Differences in our study landscapes are more subtle. Had we used color or color renditions of the photographs such as those used by Nassauer et al. (2007) that better distinguish variation in landscapes, the results might have differed.

No single image of a landscape represents the desired state of vegetation because, as demonstrated by Fuhlendorf et al. (2012), no single state is best for everything. Our intent in this research on landscape preference was not to discover a single best state, but rather, to determine to what extent population groups might differ in what they consider as the "best" state. Indeed, assuming a single best state might exist is contrary to what we know about the value of heterogeneity—i.e., that having more than a single state is more likely to provide a broad suite of values. That each population group "disliked" at least one landscape indicates a gulf between visual preference expressed by that population group and suitability of a state to provide value in terms of biodiversity or other values, even though the state might not provide the greatest value for production agriculture.

IMPLICATIONS

Preference across our study population groups for heterogeneity in patterned images suggests that preference for homogeneity is acquired. This result should encourage researchers and technical specialists to fashion intervention strategies to increase preference for heterogeneous landscapes if biodiversity is the goal. However, our results suggest that forb abundance might be an important factor that interacts with heterogeneity as an explanation for landscape preference. A bottleneck to adoption of heterogeneity management among grassland and rangeland professionals and ranchers might be an aversion to forbs and a preference for abundant grass. A local community that supports current, traditional management practices and the homogeneous, uniform landscape it produces might further constrict that bottleneck.

An intervention strategy to heighten appreciation of heterogeneity and of forbs deserves further research and development. Because grassland specialists preferred homogeneity more than did ranchers, and because grassland specialists provide information to ranchers, influence policy decisions, and have means to conduct highly visible community campaigns, intervention should likely begin with grassland specialists. Greater heterogeneity and the presence of forbs have been demonstrated, respectively by Limb et al. (2011) and Fuhlendorf et al. (2009), to lack negative implications for grazing. Successful interventions, however, require more than providing information or education. Introducing new, alternative management practices requires practitioner acceptance before adoption occurs. Educational support such as hands-on, experiential learning and demonstration projects that are visible to the larger community are elemental for achieving implementation (Roberts 2006; Mealor and Frost 2012). Differences in preference among study populations (including both geographic and role) for landscape heterogeneity suggests that interventions to increase preference for heterogeneity should be tailored for the population. This is true both among locations and among manager and nonmanager groups. For change to occur, the change agents require support from within the local community (Kreuter et al. 2008). Successful change in land management practices requires inclusive support of all user groups, agency land managers, production land managers, and the general population (Bauer et al. 2008; Howley 2011; Morris et al. 2011).

ACKNOWLEDGMENTS

We thank Mark Gregory, Associate Researcher, Department of Natural Resource Ecology and Management, Oklahoma State University, for his assistance in preparing the survey photographs for analysis. We also thank the graduate students who pilot tested the survey and assisted with evaluating photographs, and the undergraduate student workers for all of their work telephoning nonresponders. We thank the Cooperative Extension Service in Oklahoma, Kansas, Nebraska, and Texas for encouraging participation in this project and to the many extension educators who assisted in distributing the survey to their constituents. We also thank the Kansas Grazing Lands Coalition, the Patch Burn Working Group, and the Texas Panhandle Prescribed Burn Association for assistance in distributing surveys. We also wish to express our appreciation to the NRCS grassland/rangeland specialists for their participation in the survey. Funding was provided by USDA–AFRI Managed Ecosystems grant #2010-85101-20457 and by the Oklahoma Agricultural Experiment Station.

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