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A sparsely populated region with highly variable weather set against grassy, rolling land, the Great Plains stretches westward from the Missouri River at Omaha and Kansas City to the Rocky Mountains, and northward from southern Texas into the Canadian Prairie Provinces.

The region invites inquiry into the relationships between its natural environment and the cultures brought to it by its various inhabitants, as scholars and residents work both to preserve healthy ecosystems and to build thriving human communities.

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Measuring Attitudes toward Ethanol Production and Use

A Case Study of Nebraska

Frank Tenkorang and Fletcher Ziwoya

ABSTRACT—The study investigates consumer attitudes toward the production and use of ethanol as a biofuel in the state of Nebraska. Our first hypothesis is that most consumers will have a favorable opinion of corn-based ethanol. We expect farmers and agricultural professionals especially to favor ethanol because of its economic benefits. However, we believe further research is needed to examine how other demographics would align with these preferences. The second hypothesis is that economic favorability will be greater than environmental favorability, because the economic benefits of ethanol are hardly criticized while the validity of its environmental benefits are often questioned. The study utilized an instrument to measure attitude toward ethanol production and use based on Fishbein’s theory, which stipulates that both the belief and evaluation of the belief should have key roles in defining attitude (Ajzen and Fishbein 1980), as opposed to the loose traditional definition which often leads to inconsistent and contradictory results. Findings of the study indicate that (1) in general, consumers have ambivalent feelings toward ethanol, but (2) economic favorability is significantly high.

Key Words: attitude, biofuel, corn, economy, ethanol

Introduction

The United States has become a major producer of ethanol. In 2006 it surpassed Brazil to become the leading producer in the world. The US produced about 15.8 billion gallons of ethanol in 2017, which was over 100% more than Brazil’s production of 7.1 billion gallons (RFA n.d.). Despite this production growth, ethanol production and use in the US remain controversial and are the subject of frequent economic and environmental debates. The success of the ethanol industry hinges on government support, which is influenced by society’s attitude toward the biofuel. Previous studies on this topic (2009 and 2012) found mixed attitudes toward ethanol. This study looks at how society perceives ethanol today. Policymakers will find such information helpful.

Biofuel production in the US was kindled in the early 1980s to reenergize the farming sector at a time of

agricultural oversupply (M. Balat and Balat 2009). In the years to follow, a number of major national policies such as subsidies, tariffs, and mandatory blending were instituted to regulate biofuel production: Energy Policy Act of 2005; Energy Independence and Security Act of 2007; and Food, Conservation, and Energy Act of 2008. Between 2000 and 2011, ethanol production increased significantly, from 1.7 to 13.8 billion gallons, thanks to the three energy-related policy acts. Criticism of ethanol heightened with increased production and has called into question its social validity.

Unlike sugarcane-based ethanol production in Brazil, US ethanol is corn-based. As a result, corn-producing states such as Iowa, Nebraska, Illinois, Minnesota, and Indiana have embraced its production. These states are obviously interested in the economic potential of ethanol such as the provision of alternative markets for corn producers, creation of jobs, and reduction of US dependence on foreign oil. Although the economic benefits of ethanol in the US are not attacked, detractors often say ethanol’s sustainability depends on the price of corn (main feedstock) and the price of crude oil (its com-

petitor?). On the other hand, there are opposing views stemming from environmental concerns such as negative net energy balance (M. Balat and Balat 2009) and potential land degradation (Pimentel 2009). Proponents argue that fossil fuels also have a negative impact on the environment. Global carbon dioxide (CO₂) from fossil fuel use accounts for about 65% of greenhouse gas emissions (Pachauri et al. 2014), which is an increase of 10 percentage points since 1970.

The difference in attitudes toward ethanol is real, and has led to changes in policy that have slowed down ethanol expansion. The average annual growth rate of 3.8% between 2013 and 2016 is abysmal compared to the 24% between 2007 and 2011, according to data from RFA (n.d.) and EIA (n.d.). At the same time, there is a push to increase the mandatory blending requirement to increase consumption. The push to increase ethanol-gasoline blending from 10% to 15% has been an uphill battle. Although E15 (15% ethanol–85% gasoline blend) is available in 29 states, five years after it was first sold, it is available at only 672 retail locations out of more than 110,000 (Growth Energy 2017; US Census Bureau 2018). Currently, the campaign for E15 is heavily focused on metropolitan areas, most of which are not in corn-producing states. Therefore, both high ethanol-producing states and high ethanol-consuming states have a renewed interest in ethanol. The success of such efforts will depend on public perception of ethanol. A political study by Cacciatore et al. (2012) found that Democrats who pay attention to political media content view biofuels favorably while the opposite held true for Republicans. The study also confirmed a finding by a 2009 University of Wisconsin study that found that women had a more favorable opinion about biofuels than men. The results of the two surveys (University of Wisconsin 2009; Cacciatore et al. 2012) show that even at that time, public views of ethanol as a biofuel were mixed. With the renewed interest in mandatory blending, it is imperative to revisit the topic to determine whether public perception of ethanol has changed over the last 10 years, following its initial aggressive promotion. This question is important vis-à-vis the current push to use E15 year-round because discussions are focused only on the impact on domestic distillers and exports, and not on consumers.

The study investigates consumer attitudes toward the production and use of ethanol in the state of Nebraska. Our first hypothesis is that most consumers will have a favorable opinion of corn-based ethanol. We expect

farmers and agricultural professionals especially to favor ethanol because of its economic benefits. However, we cannot tell how other demographics would align. The second hypothesis is that economic favorability will be greater than environmental favorability, because the economic benefits of ethanol are hardly criticized while its environmental benefits are often questioned.

We developed an instrument to measure attitudes toward ethanol production and use. The result of the study indicates that (1) in general, consumers have ambivalent feelings toward ethanol, but (2) economic favorability is significantly high.

Review of Literature on Environmental Concerns of Ethanol Production

Since ethanol production gained attention, many studies have delved into its environmental consequences. Regarding energy efficiency, some studies show that the energy output-input ratio of corn-based ethanol is less than that of sugarcane-based ethanol. Dias de Oliveira, Vaughan, and Rykiel (2005) put the ratio of corn-based ethanol at 1.1 compared to 3.7 for sugarcane-based ethanol. Shapouri, Duffield, and Wang (2002); Wang, Saricks, and Santini (1999); and Pimentel (2003) calculated the corn-based ethanol ratios to be 1.1, 0.96, and 0.78, respectively. The differences in the ratios are mainly due to the methodology used. Studies that included every kind of energy used in ethanol production, including energy used in machinery production and transportation of corn to distillers, report low ratios.

Ethanol production has also been blamed for soil erosion. A summary of literature by De Oliveira et al. (2005) shows that soil erosion occurs 5.2 times faster than soil formation in sugarcane fields in Brazil (Aloisi et al. 1994; Sparovek and Schnug 2001). Regarding US corn production, Pimentel and Pimentel (1996) report that soil erosion is 18 times faster than soil formation.

Both corn and sugarcane use CO₂, but fuel used in their production and subsequent production of ethanol produce CO₂. A negative CO₂ balance is desirable as it indicates reduction in the CO₂ and hence, reduction in global warming. Unfortunately, both crops have a positive CO₂ balance. Using data from other studies, Dias de Oliveira, Vaughan, and Rykiel (2005) calculated a balance of 3,122 kg per ha and 5,030 kg per ha for sugarcane and corn, respectively.

Another area in which ethanol production is often

criticized is its high water requirement. Marta et al. (2011) used a simulation study to show that 1 liter of ethanol requires over 1,000 liters of water to produce. Gerbens-Leenes et al. (2009) arrived at a similar conclusion, using different classifications of water such as rainwater, surface water, and groundwater for irrigation, and polluted water. Water requirement for ethanol distillation alone has decreased from about 6 to 3 liters per gallon of ethanol (IATP 2006).

Lastly, although ethanol's economic benefits, such as an alternative market for farmers, job creation in rural areas, and reduced dependence on foreign oil, are hardly debated, a few economic criticisms of ethanol are often raised. The first is the cost of government support. The US provided a blender's subsidy of 46 cents per gallon (about \$6 billion a year) and mandated a gradual increase in ethanol use of up to 36 billion gallons in 2022, 15 billion gallons of which is allowed to be corn-based (RFA 2009). Opponents of ethanol have lobbied for the subsidy to expire in the year 2012. Also, the government had to impose ethanol import tariff of 57 cents per gallon to protect domestic producers (Devadoss and Kuffel 2010). Removing the import tariff will reduce corn prices by 1.5% (Elobeid and Tokgoz 2008). This leads to the next criticism, which is the impact on food prices. There are several studies showing that food prices increased because of the use of corn for ethanol. According to Condon, Klemick, and Wolverson (2013), corn prices increased by 2%–3% per each billion gallon increase in ethanol production between 2008 and 2013. An extensive literature review by Serra and Zilberman (2013) found increased volatility in the food market due to ethanol production. Finally, a study by Monteiro, Altman, and Lahiri (2012) shows that while ethanol production has contributed to an increase in world food prices, the value of the dollar and the price of oil have had a similar, statistically significant, effect on food prices.

Ethanol Production and the Environment in Nebraska

Sherow (2007) describes how humans, through fire practices, migration, and resource exploitation strategies in hunting and riverine agricultural practices, have affected the grasslands in the Great Plains. In the short run, Native Americans intensely used and depleted resources in the area around them in their search for food, but the environment was able to recover when they left

the area for a new place. The arrival of the Europeans brought agricultural settlement and intensive agriculture (Hays 2000).

The Homestead Act of 1862 brought an influx of Americans into the Great Plains to take advantage of the promised free land. Five years later, Nebraska attained statehood. A significant proportion of the state lies in the part of the Great Plains where mixed grass is predominant (Sherow 2007). As grass has thrived well in the Great Plains since the glaciers retreated, corn, a member of the grass family (Poaceae), has adapted well in the region and has become the number-one crop produced in the state. The large tracks of farmlands benefited from aerial application of herbicides and pesticides (Vail 2018). As Vail (2018) puts it, "agriculture was nothing without chemicals." Aerial application of chemicals was economically beneficial to farmers as it resulted in reduced labor, higher yields, and large-scale operations. The flip side of the success of the chemicals-agriculture relationship is environmental concerns. Human actions have transformed the environment, but it was not until the mid-twentieth century that we became conscious about it (Hays 2000). Early on, economic success overshadowed any environmental concerns.

Efforts to minimize the impact of human activities on the environment have never been easy. According to Drake (2013), an individual ethos and a mistrust of the government have complicated efforts to protect the environment. The bipartisanship efforts to protect the environment that occurred in the golden era (1910–14) have given way to an era of constant conflicts between Democrats and Republicans on environmental protection regulations (Drake 2013). Drake describes how most Americans have mixed feelings over the market economy and environmental concerns. According to Hays (2000), "If there is any issue that continually shapes the debate over environmental affairs it is that of the 'environment and the economy.'" He calls the relationship "environmental economy" because the economic focus is on consumption rather than on production. The ongoing debate about ethanol production and use in the US is a continuation of this conflict, and as it turned out, involves Nebraska, one of the Great Plains states and a major producer of corn, the main feedstock of US ethanol.

Nebraska produced 2.17 billion gallons of ethanol in 2017, which accounted for about 13.9% of US production. Ethanol production has benefited from the abundant supply of corn in the state, and its efficient

rail transportation. Nebraska produced about 1.7 billion bushels of corn in 2016 (third in the country) and used over 41% for ethanol production. It is worth emphasizing that the third-largest producer of corn is the second-largest ethanol producer. The state's commitment to ethanol production is seen in the fact that it is the only state with a government agency solely focused on ethanol development (Tenkorang and Bridges 2016). The Nebraska Ethanol Board, established in 1971, has been instrumental in the growth of ethanol plant construction and operation throughout the state. The first ethanol plant in the US was built by the US Army in the 1940s in Omaha, NE (Fuel Testers 2009); however, commercial plants started in the 1980s. The number of ethanol plants in the state has increased from one in 1985 to 15 in 2006, and to 25 in 2017. These plants make significant economic contributions in their respective communities. According to the Nebraska Ethanol Board, the 25 ethanol plants represent a capital investment of US\$5 billion in Nebraska and contribute directly to about 1,300 jobs.

Nebraska is the ideal state for this case study because of the importance of agriculture to the state, and because of its strong support of ethanol, it being the only state with an ethanol board. Future studies will include all 50 states in a more comprehensive study to gauge how the dynamics play out at national level. The following section presents the methodology used in the study.

Methodology

Ethanol could be called a social object, in which multiple people are interested but behave differently toward (Brousmiche et al. 2016). Behavior toward a social object is determined by attitude (Trafimow and Finlay 2002). An attitude is a measure of the degree to which an individual has a favorable or an unfavorable opinion of a concept (Norwood and Lusk 2008).

We define attitude as a belief-wish-emotion (Bakhle 2016). Following Bakhle's (2016) illustrations, if someone thinks that ethanol is good (belief), then he or she would like to use it (wish), and he or she would be happy (emotion). Since emotions vary in intensity, attitudes also vary in strength. Another dimension of attitude is the evaluation of the belief, which reflects the attributes an individual associates with a product (Norwood and Lusk 2008). The interest in attitudes emanates from their resulting impact on behavior and actions. Actions such

as the production, purchase, and use of ethanol are driven by the strength of the attitude toward the biofuel, which is itself a product of many beliefs about ethanol. Attitudes are often misunderstood because of the confusion surrounding how beliefs, evaluations of the beliefs, and behavior, or actions, contribute to it (Johnson 2002). Attitudes can be measured quantitatively or qualitatively. The study utilized both quantitative and qualitative analyses to examine people's expressed attitudes toward ethanol production and use.

Quantitative Analysis

There are several measures of attitude, and they are classified as either a direct or an indirect measure. Direct measures of attitudes use ratings such as a Likert scale or bipolar scale. Direct measures tend to produce social desirability bias. Indirect measures, such as the thematic appreciation test, do not have the social desirability bias but are deemed unethical because the respondent is unaware of the intent of the test (McLeod 2009). Attitudes influence intentions, which in turn influence behaviors, and thus there are several attitudinal-behavioral models that attempt to explain this relationship. Some of the models measure attitude as a binary value, and others measure it as a continuous value (Brousmiche et al. 2016). The Fishbein model, which was chosen for this study, is based on a direct measure of attitude and is an ethical method that allows the inclusion of multiple attributes of the social object under consideration (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). Also, it produces continuous values of attitude using a very simple method. According to Fishbein's theory, both the belief and evaluation of the belief should have key roles in defining an attitude, as opposed to the loose traditional definition, which often leads to inconsistent and contradictory results (Bright et al. 1993). Using a quantitative approach, as suggested by Fishbein's theory, we measured and analyzed attitudes as a product of the strength of the belief the individual had about ethanol and the evaluation of the belief. The attitude (A_0) is computed as follows:

$$A_0 = \sum_{i=1}^N B_i E_i \quad (1)$$

where B_i is the strength of the belief that ethanol is associated with attribute i , and E_i is evaluation of belief i . N is the number of belief items. These measures (B and

E) were obtained via a survey of about 450 respondents who were asked whether they agreed or disagreed with 14 beliefs, and correspondingly, were asked to evaluate these belief statements on a five-point Likert scale, 1 being strongly disagree and 5 strongly agree. This scale deviates from Fishbein's scale, which ranges from extremely negative (extremely bad) to extremely positive (extremely good). The negative-positive scale, also known as the bipolar scale, assumes double-negative logic, which makes positive or negative framing of statements irrelevant. Trafimow and Finlay (2002) could not confirm the double-negative logic postulated by Fishbein. They attributed their results to the fact that people find it more difficult to process negative statements compared to positive statements. In this study, the belief statements and their evaluations were framed positively about ethanol production and use. A bipolar scale will not differentiate between a -2 belief with a -2 evaluation and a 2 belief with a 2 evaluation, whereas a 2-2 and a 5-5 on a 1-to-5 scale will yield 4 and 25. Computed attitude measures (A_0) based on the 14 beliefs/evaluations will fall between 45 and 350. Using the mean and the standard deviation, respondents were categorized as strongly favorable, favorable, unfavorable, and strongly unfavorable. These categories were cross-tabulated by demographical information. Ordinary least squares (OLS) analysis was used to substantiate the cross-tabulation results.

The respondents were drawn from eastern, central, and western regions of Nebraska. The eastern region includes Lincoln and Omaha; the central includes the area between York and Lexington; and the western represents west of Lexington. The initial plan was to administer an approximately equal number of surveys in each region. However, student researchers assigned to the eastern region unexpectedly dropped out, resulting in significantly fewer surveys for that region. Considering the fact that the ethanol debate hinges on economic and environmental factors, the economic and environmental-related beliefs/evaluations were separated in order to test our second hypothesis.

Qualitative Analysis

For various reasons, a qualitative methodology was adopted in addition to the quantitative approach to explore Nebraskans' perceptions of and attitudes about the production and use of ethanol as a biofuel. A qualitative

approach is flexible and allows an in-depth exploration of respondents' attitudes, experiences, and feelings. In addition, qualitative methods generate a wide range of ideas and opinions that individuals hold about issues, as well as divulge viewpoint differences among various groups on those issues. Furthermore, for under-researched topics, qualitative methods attempt to fill in gaps left by survey-based research. Therefore, in line with the objectives of this study, qualitative questions were added to the questionnaire in order to identify some of the factors underlying the attitudes that were measured quantitatively.

Perspectives informing our qualitative methodological approach are grounded in critical, collaborative, and lived experience of the participants (Lindlof and Taylor 2002; Merriam 2002). Babbie (2004) defined a qualitative study as "an in-depth examination of a single instance of some social phenomenon, such as a village, a family or a juvenile gang" (293). Babbie indicated that the main characteristic of a qualitative approach is the focus on a specific instance of the social phenomenon under study. Stake (1995) argued that a qualitative study is less of a methodological choice than "a choice of what is to be studied" (435). Because qualitative studies focus on a specific unit, generalization becomes an issue. However, some scholars have pointed out that much can be learned from specific cases (see Eisenhardt and Graebner 2007; Baxter and Jack 2008). Stake (1995) stated that readers can learn vicariously through an encounter with qualitative study findings. While we do not claim generalization in this study, we aim at providing a rich description of the various views as expressed by respondents to shed more light on the general feeling regarding the production and use of ethanol in Nebraska.

Results

Description of the Respondents

The total number of respondents was 434, comprising 63% males and 35.6% females. The remaining percentage chose not to disclose their gender. The central region accounted for 55% of the respondents, followed by 33% from the western region and 12% from the eastern region (12%). It is worth noting that about 63% of eastern region respondents do not view ethanol favorably. Respondents in the central and western regions have a relatively balanced favorability. Figure 1 shows percentage distribution of the respondents by occupation,

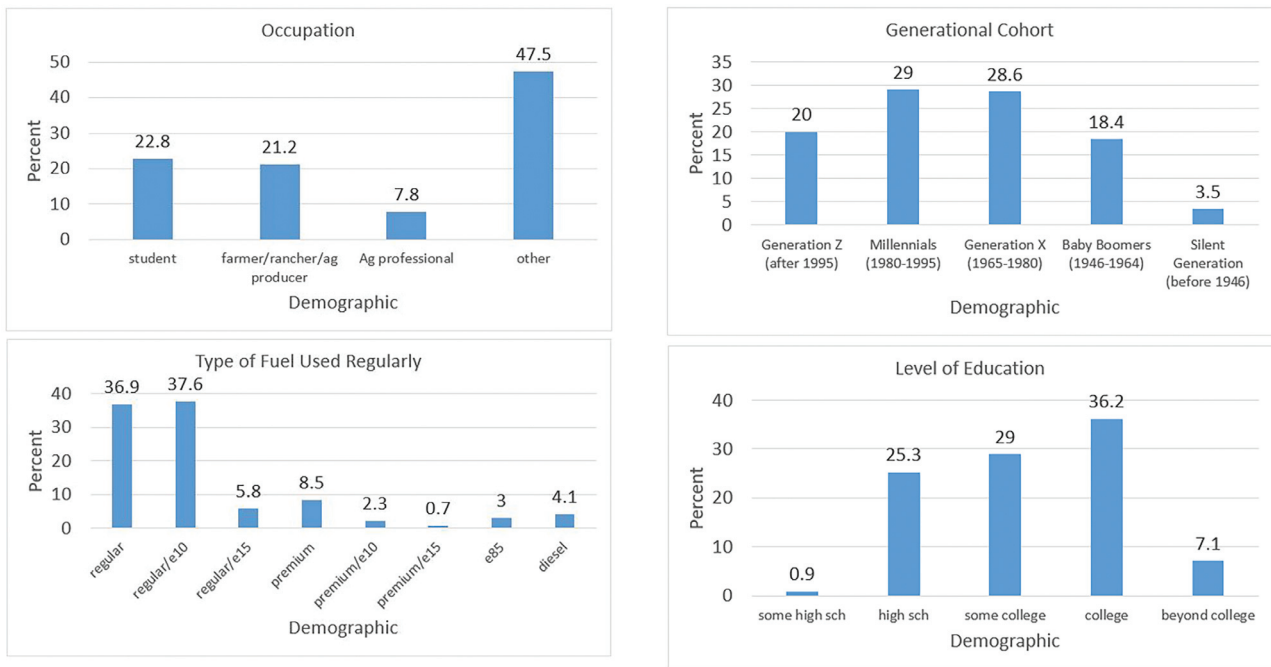


Fig. 1. Description of respondents.

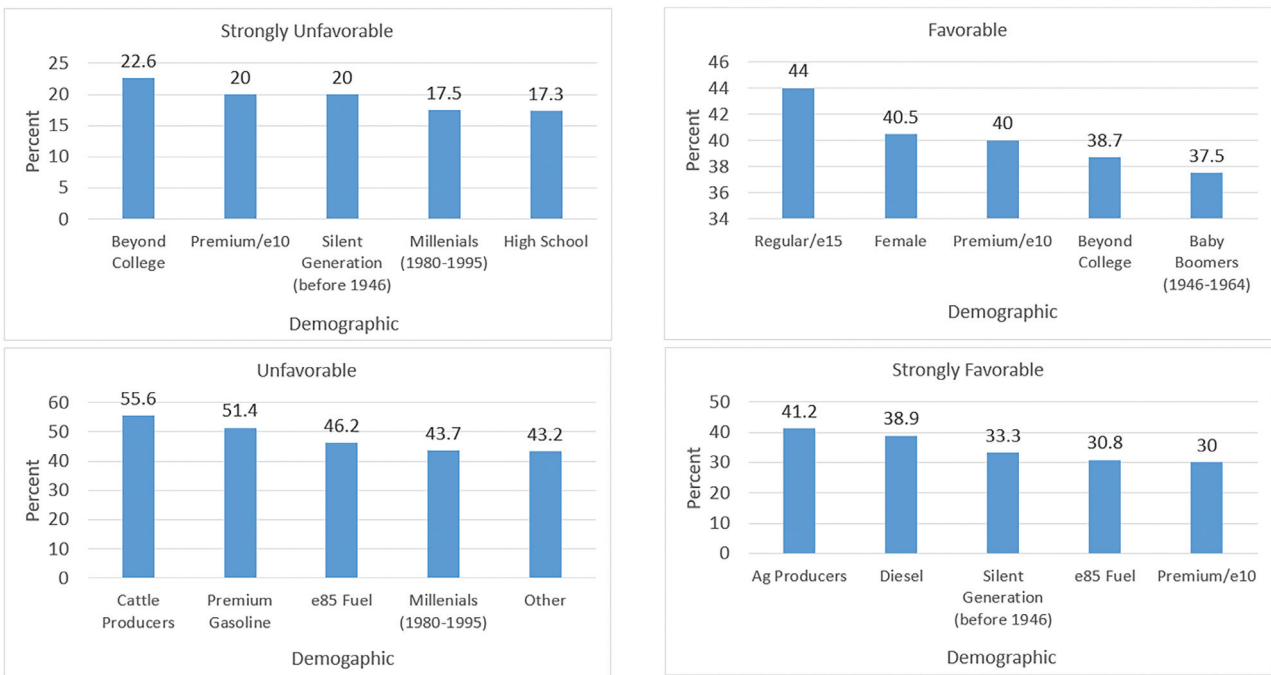


Fig. 2. Five top demographics by attitudinal category.

Table 1. Four categories of favorability.

Attitude score (A_o)	Favorability	Percentage
Less than 138.7	Strongly unfavorable	13.2
138.8 to 193.1	Unfavorable	37.7
193.2 to 247.5	Favorable	32.9
Greater than 247.5	Strongly favorable	16.2

generational cohort, level of education, and type of fuel used regularly.

About 23% of respondents described themselves as students, and 21.3% as agricultural producers, most of whom produced corn and soybeans. Over 90% of the respondents completed at least high school and about 37% completed college. The popular fuel used by the respondents are regular-E10 (38.0%) and regular gasoline (37.3%).

Attitude Measures

The computed attitude measure (A_o) ranges from 45 to 350 with a mean of 193.1 and a standard deviation of 54.4. Using the mean and standard deviation, four categories of favorability are presented in Table 1.

In general, attitudes toward ethanol production and use can be said to be mild, as only about 30% of respondents either have a strongly favorable (16.2%) or a strongly unfavorable (13.2%) opinion toward it. A cross-tabulation of the attitude score by demographic variables reveals the source of these results, that is, who is likely to have a specific attitude toward ethanol.

Figure 2 shows the percentage of the top five specific demographical groups in the four attitudinal categories. To ensure that the analysis is reliable, demographics with less than 10 observations were excluded from this figure. The five demographics in each category are highly variable.

In top left quadrant, 22.6% of respondents with a beyond-college-level education have a “strongly unfavorable” attitude toward ethanol. Interestingly, demographics expressing an “unfavorable” attitude (bottom left) have percentages that are more than twice those of the “strongly unfavorable.” For instance, 55.6% of cattle producers are in the “unfavorable” group compared to the 22.6% in the “strongly favorable” group. The high percentage among cattle producers could be stemming from the upward pressure of ethanol on corn price. For

Table 2. Regression results of attitude on demographics.

	Coefficients	Robust std. error
Intercept	188.35***	15.762
Student	15.68*	7.446
Farmer	22.48***	6.681
Ag professional	39.06***	11.987
Generational cohort	2.20	3.21
Gender	-9.00*	4.872
Education	1.02	2.587
FuelTypeo	2.47	5.039

*p < 0.10, **p < 0.05, ***p < 0.01; Breusch-Pagan chi = 12.81*** R² = 0.061; VIF = 1.28

the “favorable” and “strongly favorable” categories, it is not surprising that E15 users and agricultural producers have the highest percentages, respectively.

The next analysis collapses the four categories into two, “favorable” and “unfavorable,” to see where each demographic group lies. The results are presented in Figure 3.

Most agricultural professionals (such as crop consultants, seed and fertilizer dealers, brokers, etc.) have a favorable attitude toward ethanol. The regression results show that agricultural professionals’ favorability is statistically significant. Being an agricultural professional increases the attitudinal measure by 39 points (Table 2). This could be coming from the perceived positive economic impact of the industry on rural areas. The majority of farmers and students share similar opinion. They have positive and statistically significant coefficients as well. Attitudinal measure is about 16 and 22 points higher for students and farmers, respectively. The cross-tabulation results show that with the exception of millennials, the majority of all the generational cohorts are in favor of ethanol production and use (Fig. 3). Although the generational cohort is not statistically significant (Table 2), the positive coefficient means that favorability toward ethanol wanes with age, as moving to an older cohort increases favorability. In the other categories, 60% of hog producers and 53% of corn producers are in favor of ethanol. Regarding fuel type, the ordinary least squares results show that regular users of ethanol have higher favorability due to the positive coefficient. The coefficient is, however, not statistically significant. The positive coefficient is driven by premium-E10 and regular-E15 users, seeing as 70% and 64% of users, respectively, are in favor of ethanol. This higher favorability among premium-E10 and regular-E15 users

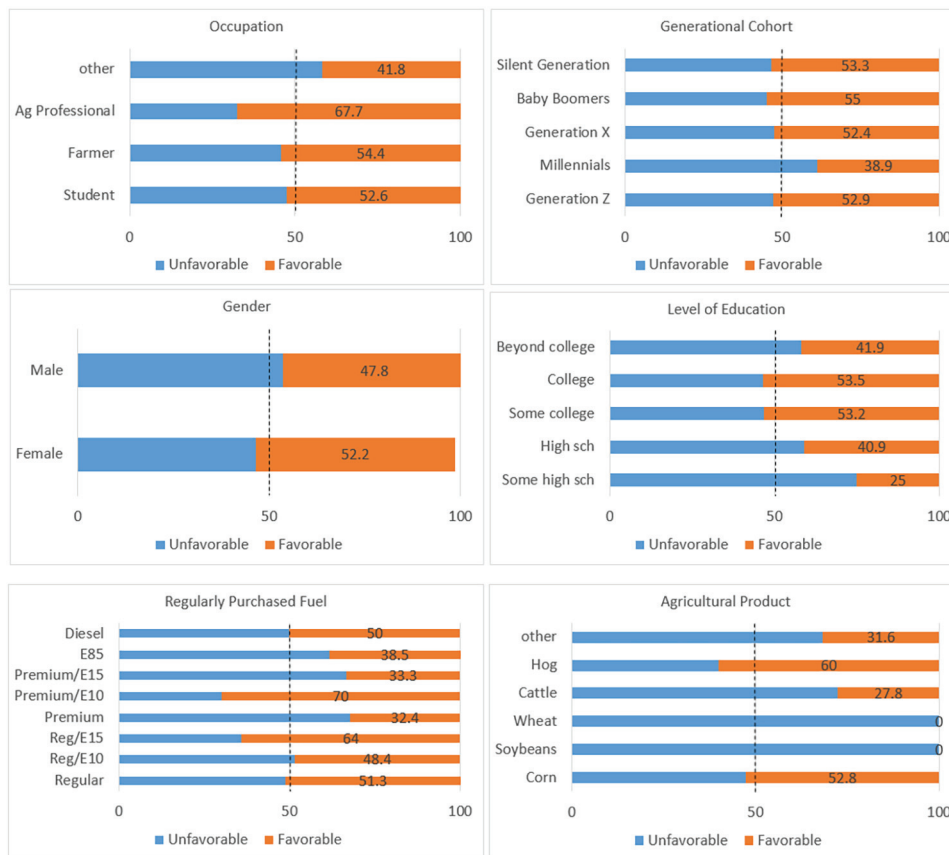


Fig. 3. Percentage of respondents with “unfavorable” and “favorable” attitudes by demographics.

is important, as higher blends (E15 and above) are currently being promoted, especially in metropolitan areas. Blends of E15 and above with premium gasoline may not be well received. The cross-tabulation results show that about 53% of respondents with college or some college education favor ethanol. This favorability is confirmed by the positive education coefficient, although it is not statistically significant. Finally, ethanol promotion should target women, as a higher percentage of women over men are likely to use ethanol. On average, females’ favorability measure is nine points higher than that of males, and it is highly significant at 1% test level.

Overall, the quantitative results show that attitude toward ethanol is mixed, a result that is similar to the two previous studies. Therefore, our results do not support the first hypothesis, that most consumers will have a favorable opinion of corn-based ethanol.

Our second hypothesis, which states that economic favorability will be greater than environmental favorability, is tested in the following section.

ECONOMICS VERSUS ENVIRONMENTAL CONCERNS

Separating the attitudinal measure (A_o) into economic and environmental reasons presents some staggering results, bearing in mind the relatively mixed results up to this point. The percentages of respondents with favorable attitudes toward ethanol for economic reasons are mostly above 90% while those favorable for environmental reasons are about 50% (Table 3). While the correlation coefficient between the economic and the environmental scores is highly positive (0.78), the mean score for economic reasons is 110.54 compared to 70.34 for environmental reasons. Two sample t -statistics of 22.69 indicate the economic mean score is statistically significantly greater than that of the environment at 0.05% test level. The implication of these results is that the favorability of ethanol is heavily driven by its economic benefits rather than its environmental benefits. These results support the second hypothesis.

Overall, the results show differences by demograph-

Table 3. Percentage of respondents with unfavorable and favorable attitudes, by economic or environment reasons.

	Unfavorable		Favorable	
	Economic reasons	Environment reasons	Economic reasons	Environment reasons
Gender				
Female	5.9	49.7	94.1	50.3
Male	8.8	53.0	91.2	47.0
Other	50.0	83.4	50.0	16.7
Occupation				
Student	9.1	46.4	91.0	53.5
Ag producer	9.7	47.8	90.2	52.2
Ag professional	5.8	41.2	94.1	58.8
Other	7.7	58.7	92.2	41.3
Generational cohort				
Generational Z	8.0	47.1	92.0	52.8
Millennials	8.0	66.7	92.1	33.3
Generation X	4.8	49.2	95.2	50.8
Baby Boomers	11.3	43.8	88.8	56.3
Silent Generation	26.7	33.3	73.4	66.7
Education				
Some high school	25.0	50.0	75.0	50.0
High school	10.9	60.0	89.1	40.0
Some college	6.4	49.2	93.7	50.8
College	6.3	47.1	93.6	52.9
Beyond college	12.9	58.1	87.1	41.9
Fuel type				
Regular	8.8	52.5	91.3	47.5
Regular-E10	6.8	52.2	93.3	47.8
Regular-E15	12.0	44.0	88.0	56.0
Premium	8.1	67.6	91.9	32.4
Premium-E10	10.0	30.0	90.0	70.0
Premium-E15	33.3	33.3	66.7	66.7
E85	7.7	46.6	92.3	53.9
Diesel	11.2	50.0	88.9	50.0

ics, but they do not reveal what drives these attitudes. Qualitative analysis will explore these drivers.

Qualitative Results

The qualitative part of the study is built on the narrative part of the questionnaire. About 28% of respondents provided qualitative comments that were used to analyze the respondents' perceptions of and attitudes

about the use and production of ethanol. Analysis of qualitative responses to the questionnaire occurred in three phases. First, interview transcripts were reviewed several times, searching for "recurring themes" (Merriam 2002). Quotes and phrases from the responses that were significant to the study were highlighted, using the constant comparative method (Glaser and Strauss 1967). Researchers went back and forth through responses until categories emerged that

Table 4. Summary of respondents' comments.

Positive comments	Frequency	Negative Comments	Frequency
<i>Economy</i>		<i>Government</i>	
It helps the economy; Help me in my business; Ag economy stimulator	3	Government subsidies	2
Lower gas prices and local jobs	1	I think anything the government has to subsidize is bad.	3
My husband hauls [distillers grain]; it's our livelihood	1	I think of corn, and poor policies	1
Good for Nebraska	1	Ethanol is not what they say it is. It is a public relations ploy.	1
The future for ag marketing/helping farmers	7	<i>Damage to Vehicles</i>	
Livestock feed	3	I am scared to use it in my vehicle/damages fuel injectors	2
<i>Environment</i>		Fuel pumps and systems being ruined in older vehicles	1
Clean fuel/renewable energy source	17	Low fuel mileage	1
Better [miles per gallon]	1	<i>Environment</i>	
American energy	1	Worsens air quality	1
<i>Others</i>		The smell it produces at the plant	1
Ethanol should be used; Make more; cheaper fuel environment	3	Lots of water needed to produce	1
Neutral Comments		Using our food source for a less than desirable end result	1
More money. More problems; has its benefits. Doesn't rule.	2	<i>Others</i>	
Great potential; depletes other valuable resources to produce	1	Not good/bad/ethanol is a joke; Driven by greed	4
Alternative source of energy; not optimal replacement for fossil fuels	2	Why are we promoting this?	1
Corn	28		
I really don't know enough about ethanol to have an educated opinion.			

were consistent and distinct (Marshall and Rossman 1989). The qualitative study based on a constructivist paradigm used a phenomenological strategy to explain the respondents' feelings toward ethanol. Categories were named and coded accordingly (Bogdan and Biklen 1982; Merriam 2002). Most of the comments could be categorized as negative, positive, or neutral.

Whether by default or lack of information, when asked to share in one sentence what came to the respondents' mind when they heard the word "ethanol," most respondents mentioned "corn" (Table 4). Corn was mentioned about 28 times, which obviously is due to corn being the main feedstock of ethanol production in the US. In response to the same question, other views expressed included the fact that corn-based ethanol was not the answer to substituting fossil fuels; as one

respondent put it, "An alternative source of energy that is still not the most optimal replacement for fossil fuels." Other comments ranged from skepticism and viewing ethanol as not viable and not able to match the current energy demands. One respondent asked, "Why are we promoting this?" One of the qualitative questions on the survey asked respondents for a comment on ethanol production that the survey did not cover. One respondent had this to say: "I think anything the government has to subsidize is bad." There were six comments questioning government support of ethanol. Other negative comments include impact on vehicles (4) and the environment (4).

Respondents who had positive perceptions of ethanol production and use regarded the biofuel as something that will help farmers in the United States. One

respondent said corn-based ethanol was a creative way to use corn and help fuel vehicles. Yet another respondent regarded ethanol production as an “Ag economy stimulator.” Overall, there were 16 positive comments regarding economic benefits of ethanol (Table 4). Other positive responses urged more production of corn-based ethanol, saying it was good for Nebraska. Positive terms used to describe corn-based ethanol included “clean energy” and “cleaner fuel.” There were 18 such comments. It is worth mentioning that some of the comments such as “More money. More problems,” “has its benefit. Doesn’t rule,” and mere mention of “corn” were deemed to be neutral comments (33 overall). The positive comments can be identified as economic or environmental while the negative comments can be identified as criticism of government support, unsuitable for vehicles, and environmental. These are the factors underlying the attitudes measured by the quantitative method. The qualitative responses support the overall quantitative results and the general literature on ethanol production.

In summary, thematic content analysis indicated five major areas of interest:

1. Respondents demonstrated lack of familiarity with ethanol production.
2. Current practices among farmers and ethanol fuel users.
3. Acceptance of ethanol as a biofuel was accompanied by mixed feelings, without a strong bias either way as to whether or not it is essential for the economy.
4. Several barriers to the use of ethanol were revealed.
5. Majority of the respondents demonstrated lack of awareness of and ambivalence about the process and benefits of ethanol production as a biofuel. Lack of personal interest in or knowledge of ethanol production, and poor public information, contributed to the lack of appreciation for the biofuel.

Conclusion

Agriculture has been the backbone of Nebraska’s economy since its statehood. The grasslands of the state are suitable for corn production, and subsequently for cattle production, because of the availability of an abundant corn supply. Unsurprisingly, corn and cattle

have become the most important commodities in the state. In addition to corn and cattle production, ethanol production has become essential to the state because it uses corn, and its by-product, distillers grains, serves as cattle feed. One would expect the state to embrace ethanol production and use. However, due to environmental concerns, some Nebraskans have misgivings about ethanol.

As demonstrated by the quantitative and qualitative analyses presented above, respondents to our survey had mixed feelings about the production and use of corn-based ethanol in Nebraska. Findings indicate that there is a need for more education and information on the processes and benefits of corn-based ethanol in the state. Stakeholders need to reach out more in order to educate the general populace on the objectives, processes, and benefits of biofuels.

The one-state analyses do not allow a comparison between attitudes in ethanol-producing states and nonproducing states. However, we can conclude from the quantitative and qualitative results that, overall, Nebraskans have a weak preference for ethanol, findings which are similar to those of Cacciatore et al. (2012) and University of Wisconsin–Madison (2009). While Cacciatore et al. (2012) attribute their findings to perceived environmental benefits, our favorability finding is driven by the perceived economic benefits such as job creation, alternative markets, and reduced dependence on foreign oil rather than on environmental factors such as reduced greenhouse gases and positive net energy balance. It is worth mentioning that our results do not diminish the importance of environmental concerns. As we noted in the section “Ethanol Production and the Environment in Nebraska,” the historical agricultural economic success that initially overshadowed environmental concerns about ethanol production could be repeating itself.

While ethanol favorability remains ambiguous, production is likely to surge. The current US administration has ordered the Environmental Protection Agency (EPA) to allow full-year sale of E15. Also, China plans to at least quadruple its ethanol consumption by mandating nationwide E10 use (Li et al. 2017). Due to insufficient domestic feedstock, China will need to import significant amount of ethanol, which presents a golden opportunity for US distillers. Currently, the US exports over \$300 million worth of ethanol to China. Both policies (E10 in China and E15 in the US) will take a while to affect the market because most fuel stations in the US are not equipped to dispense E15 and China has a

45% tariff on US ethanol (RFA 2018). Fuel stations will need government support to replace their pumps, and ethanol exports will benefit from trade renegotiations between the US and China.

An area of further research could be a comprehensive study to see how the perspective on ethanol production and use compares nationwide. The findings in this study indicate a strong need for more education and information in the processes and benefits of ethanol as a biofuel, especially now that E15 is being promoted.

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“Humbled by Nature”

A Rancher’s Mental Model of Adaptation in the Great Plains

Hailey Wilmer and Jim Sturrock

ABSTRACT—Ranchers in the Great Plains make decisions in complex social and ecological environments. While a great deal of research has studied rancher adaptation, an *emic*, or insider’s, view of rancher’s mental models is less well understood. In this study a rancher and a researcher collaborate to document ten years of management on a Colorado ranch. Using data from repeated interviews, participatory mapping, and records review, we describe a conceptual model for ranch decision-making. Then, we illustrate the spatial ecology of these decisions via a participatory map. Finally, we show management, climate, and ecological records over ten years. This timeline illustrates how the rancher’s management approach and relationship to the ecosystem changed over time, from viewing himself as the “controller” of the ecological community to “member of it.” We discuss how our results complement existing research about ranch systems adaptation by documenting how climate, weather, and economic and ecological dynamics interacted with the rancher’s own self-image and how management strategies changed over time. Our collaborative methodology and the resultant mental model may inform other first-generation ranchers seeking to develop adaptive management approaches, and researchers seeking to better understand the decision-making environments of their rancher collaborators.

Key Words: adaptive management, eastern Colorado, livestock production, rangeland management, shortgrass steppe

Introduction

This article presents an *emic*, or insider’s, view of ranch decision-making for a ranch in the western Great Plains. Ranching has a role in biodiversity conservation, rural community well-being, and food systems across the Great Plains and beyond (Brunson and Huntsinger 2008; Charnley, Sheridan, and Nabhan 2014). Yet outreach professionals, researchers, and agency employees from nonranching backgrounds may have little experience with how and why ranchers make the decisions they do. Here we describe the ranching context of the western Great Plains and review existing social science on ranch adaptation and decision-making. We argue that a description of a rancher’s view, or *mental model*, of the ranch the rancher manages, produced in collaboration between a rancher and researcher, provides a novel window into ranching systems. Drawing from six

years of collaboration, we describe a rancher’s sources of information and goals, and use his view of ranch decision-making, to organize ten years of history on a ranch in Grover, Colorado. Finally, we discuss lessons learned for the researcher and the rancher from this exercise, and consider implications for ranch decision-making research and other ranchers.

Ranching Context of the Western Great Plains

Cattle ranching livelihoods in the western Great Plains balance among dynamic climatic, ecological, economic, and sociocultural systems. Once on the front edge of American colonial project, ranching operations today are shifting, if slowly, with larger social, economic, technological, and political structures. These family ranch businesses span the boundaries of generations, worldviews, and social and ecological processes through a complex web of human-nature relationships (Brunson and Huntsinger 2008; Sluyter 2012; Bennett 2017). Ranchers manage for a variety of conservation and

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production goals, balancing demands from urban and rural cultures, while dealing with multiple, complex drivers of food system and economic change (Sayre et al. 2013; Huntsinger and Oviedo 2014; Lien et al. 2017).

Family-operated beef ranches in the region remain low-input operations. They rely on forage from forage crops, hay, and extensively managed rangelands, including native and restored shortgrass steppe and mixed-grass prairies. These resilient ecosystems evolved under heavy grazing pressure, highly variable weather conditions, and the effects of small mammals and fire (Milchunas and Lauenroth 1993; Knapp and Smith 2001; Fuhlendorf et al. 2012; Porensky et al. 2017). Where soil and climatic characteristics preclude tillage, these extensively managed rangelands “stitch the world together” (Box 2015) by connecting more economically productive urban, suburban, agricultural, and wildland areas with space for economic, ecological, cultural, and religious activities (Snyder 2010; Sayre et al. 2017). In the Great Plains where grassland systems are a fraction of their pre-European area, these landscapes provide important habitat for a suite of grassland bird species threatened by land-use conversion, farming, and climatic change (Brennan and Kuvlesky 2005; Engle, Coppedge, and Fuhlendorf 2008; Augustine and Derner 2012; Sylvester, Gutmann, and Brown 2016). Growing public concern for biodiversity conservation in the region has re-centered private land managers as key stakeholders in conservation efforts through heterogeneity-based management approaches, particularly for grassland birds (Derner et al. 2009; Fuhlendorf et al. 2012).

In arid and semiarid rangelands, where “anthromes (anthropogenic biomes) meet their limit” (Sayre et al. 2017) ranching and pastoral systems must remain flexible if they are to sustain livestock production under high levels of variability within and among years in primary production and precipitation, and changing climate contexts (McAllister 2012; Huntsinger and Oviedo 2014; Derner and Augustine 2016). Matching forage demand to supply is a key challenge in these dynamic conditions, a task that challenges ranchers operating in complex and globalizing market contexts (Ritten et al. 2010; Torell, Murugan, and Ramirez 2010; Hamilton et al. 2016). In the Northern Plains, ranching systems face a future shaped by increased precipitation variability, invasion of non-native annual grasses, increase in woody species, and heat-related challenges under future emissions scenarios, which will require additional adaptive and transformational change by livestock producers (Morgan et

al. 2011; Polley et al. 2013; Mueller et al. 2016; Derner et al. 2018).

Social Science on Ranch Decision-Making and Adaptation

Social scientists have taken various approaches to examining ranch-system adaptation to social and ecological dynamics. Below we review this wide body of work briefly, covering evaluations of ranch system adaptation, rancher culture and motivations, and on-ranch management strategy and innovation adoption to inform our study of rancher decision-making. We also discuss research specific to the Great Plains, where social science in agriculture has contributed to knowledge of adaptation to extreme weather and economic events (Rudel 2018).

Ranch System Adaptation and Motivations. Sluyter (2012) traced the history of the North American continent’s first ranches, using a conceptual framework based on Latour’s (2012) critique of modernism’s “great divides” between human/nonhuman and among-human relationships. He documented the African roots of grazing ecologies in New Spain. He described how Spanish colonialism developed ranch production systems and how cross-Atlantic application of African ecological and animal husbandry knowledge by enslaved and freed Blacks spurred innovation, such as horseback roping. Following the foundational work of Webb (1931), Bennett (2017) used the lens of cultural anthropology to analyze the adaptive strategies of multiple communities in the Canadian Northern Plains, including ranchers, farmers, Hutterite, and First Nations communities in the 1960s. He identified cultural, economic, and material outcomes of specific periods of settlement, establishment, and commercial ranching. Avoiding full-out environmental determinism, Bennett detailed the interconnected human, plant, and animal communities that shaped ranching culture as an “intimate ecology”:

Ranching as a cultural style has intimate contacts with natural phenomena: grass, topography, water and animals. The nostalgic attitudes held by ranchers toward the old wilderness and the wild species are in part simply the persistence of traditions based on the frontier experience, but they are also meaningful symbolizations of the intimate ecology of the ranching operation. Ranch-

ers view cattle as economic objects, but they also have mystique about these animals and their own ability to manipulate them. (197)

There is growing recognition of these interconnected social and ecological dynamics in rangeland systems in more recent research (Reid, Fernández-Giménez, and Galvin 2014; Hruska, Huntsinger, et al. 2017; Hruska, Toledo, et al. 2017), including recent ethnographic and quantitative work. Studies have explored ranchers’ “local ecological knowledge,” including multigenerational knowledge of place and of cycles of life and death (Knapp and Fernández-Giménez 2009), cultural conservation ethics (Turner et al. 2014; Lien et al. 2017), and use of multiple “systems of knowledge” (Wilmer and Fernández-Giménez 2015). Ellis (2013) critically evaluate rancher-animal relationships through the concepts of stewardship, (animal) husbandry, and dominion, concepts that create the symbiotic relationship ranchers see in their livelihoods with livestock.

Innovation Adoption. There is also a large body of research on rancher innovation adoption. Evaluations of ranchers’ decision-making has consistently indicated the context-specific aspects of ranch operations (Roche et al. 2015), and that demographic characteristics such as education, wealth, and operation size predict decisions related to production or conservation innovations (Didier and Brunson 2004; Pruitt et al. 2012; Kelley, Fernández-Giménez, and Brown 2013; Lubell et al. 2013). Risk orientation, community support, and experience and skill are important factors determining landowners’ decisions to implement ecologically important practices such as prescribed burns that have been culturally unacceptable historically (Toledo, Sorice, and Kreuter 2013). Rancher responses to specific ecological challenges, such as drought or grazing management, vary within regional or ecozone contexts to meet social and ecological constraints and opportunities (Coppock 2011; Kachergis et al. 2014; Roche 2016). Marshall and Smajgl (2013) found that Australian ranchers varied in their capacity to adapt to climate and weather extremes. This capacity was evaluated by their perception of risk, skills in planning, learning, and reorganizing, financial and emotional flexibility, and interest in adapting. Notably, first-generation ranchers may be more vulnerable to drought and have fewer information sources than multigenerational operators (Munden-Dixon et al. 2018).

Lubell et al.’s (2013) social-ecological theoretical

framework (Fig. 1) for ranch decision-making synthesized social science theory regarding multiple scales of social and rangeland ecological interactions. This reflects a complex systems perspective on ranch decision-making (Glaser et al. 2008), which serves as a helpful guide for further research of ranch-systems and ranchers (Wilmer, Augustine, et al. 2018; Munden-Dixon et al. 2018). Specifically, the model hypothesizes the relationship among key variables in ranching systems, including operation and operator characteristics, time horizon, social networks, and social values, providing a view of how economics, psychology, and social process operate simultaneously in a social-ecological ranching system. This view of ranching can help connect on-ranch management to experimentally derived rangeland ecology research knowledge, which has conventionally investigated rangeland management at different spatial and temporal scales than those at which ranchers work (Briske et al. 2011; Teague et al. 2013; Roche et al. 2015). Evaluations of rancher perceptions and barriers to adaptation and innovation adoption has repeatedly highlighted the importance of building trust between ranchers and researchers and government agencies to accomplish desired research, conservation, and livelihood outcomes (Lien et al. 2017; Wilmer, Derner, et al. 2018).

Adaptation in the Great Plains. Analysis of agriculture adaptation and decision-making in the Great Plains has been of interest to social scientists. This is, in part, because agriculture here has been well documented since settlement (Cunfer and Krausmann 2015) and because of great need for work to reduce rural poverty following drought and economic depression in the 1930s (Rudel 2018). The region provides insights into the dynamics of colonial agricultural activity, responses to climatic extremes (including the Dust Bowl, 1932–1941; see Worster 2004) and changes brought through technological innovation (Cunfer and Krausmann 2015; Bennett 2017) and emerging ecological theory (Joshi et al. 2017; Sliwinski et al. 2018). Cunfer and Krausmann (2015) and Cunfer, Watson, and MacFadyen (2018) provide extensive evaluation of Kansas agricultural adaptation from 1860 through 2000. This research describes social, economic, and environmental drivers of agro-ecosystem change during agricultural colonization and socio-ecological transition across different regions in the state. Cunfer and Krausmann (2015) trace how “Great Plains pioneers achieved their economic goals by adjusting agricultural practices to fit local environmental conditions” (379).

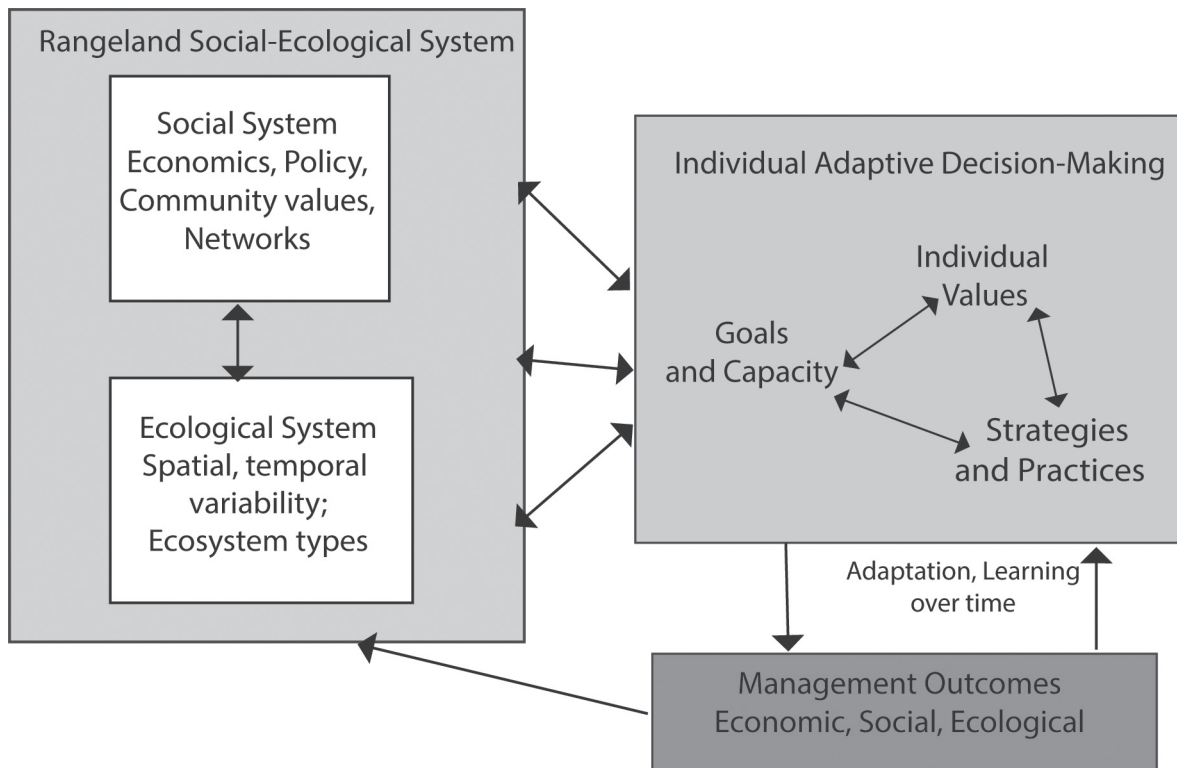


Fig. 1. Lubell et al.'s (2013) conceptual model of ranch social-ecological decision-making is foundational in current ranch adaptation research. The model hypothesizes the relationships among multiple scales of social, psychological, and economic drivers of rancher decision-making and the outcomes of those decisions. These outcomes feed into the broader social-ecological system, which accounts for spatial and temporal variability and ecosystem types.

The Dust Bowl's role in reshaping rural communities, agricultural practices, and state and federal agricultural and research programs is well documented (McLeman et al. 2014), but recent critical scholarship has questioned conventional explanations for these events (Holleman 2017). For example, Sylvester and Rupley (2012) compared archival aerial photography and contemporary soil maps to document the extent to which farmers in Depression-era Kansas broke out land unfit for cultivation and argued that New Deal land retirement programs overestimated the extent of this activity. Their evaluation of the stabilizing effect of conservation programs also indicates that conversion to farming still threatens marginal soils and native grasslands in the region (see also Drummond et al. 2012). At a broader scale, Gutmann (2018) brought to light the role of drought in agricultural failure and widespread regional demographic change in the region during the 20th century, including rural outmigration in every Great Plains county between 1935 and 1940. This historical research enhances findings from

rangeland science, anthropology, social psychology, and innovation adoption perspectives with a more complete picture of how rainfall, soil quality, and technological innovation shaped these ranch systems over the course of the industry's history in the region.

Need for the View from the Ranch Pickup. This diverse compilation of ranch decision-making research may owe itself to the diverse and complex nature of ranch systems themselves: livelihoods operating between colonial and globalizing economic eras, between rapid urbanization and slow rural depopulation, and ultimately, between rainfall events. But how do ranchers make sense of the complex world in which they learn to make a living and sustain a way of life? How do they prioritize and select among goals and objectives, and how do they see themselves in this complex web of social and ecological relationships? What does ranching look like from the driver's seat of the ranch pickup truck? The *emic*, or insider's, view of ranching is expressed in western art, poetry, music, and the many memoirs and oral histories of ranchers (Cannon 1985; Baca Gilbert 1994),

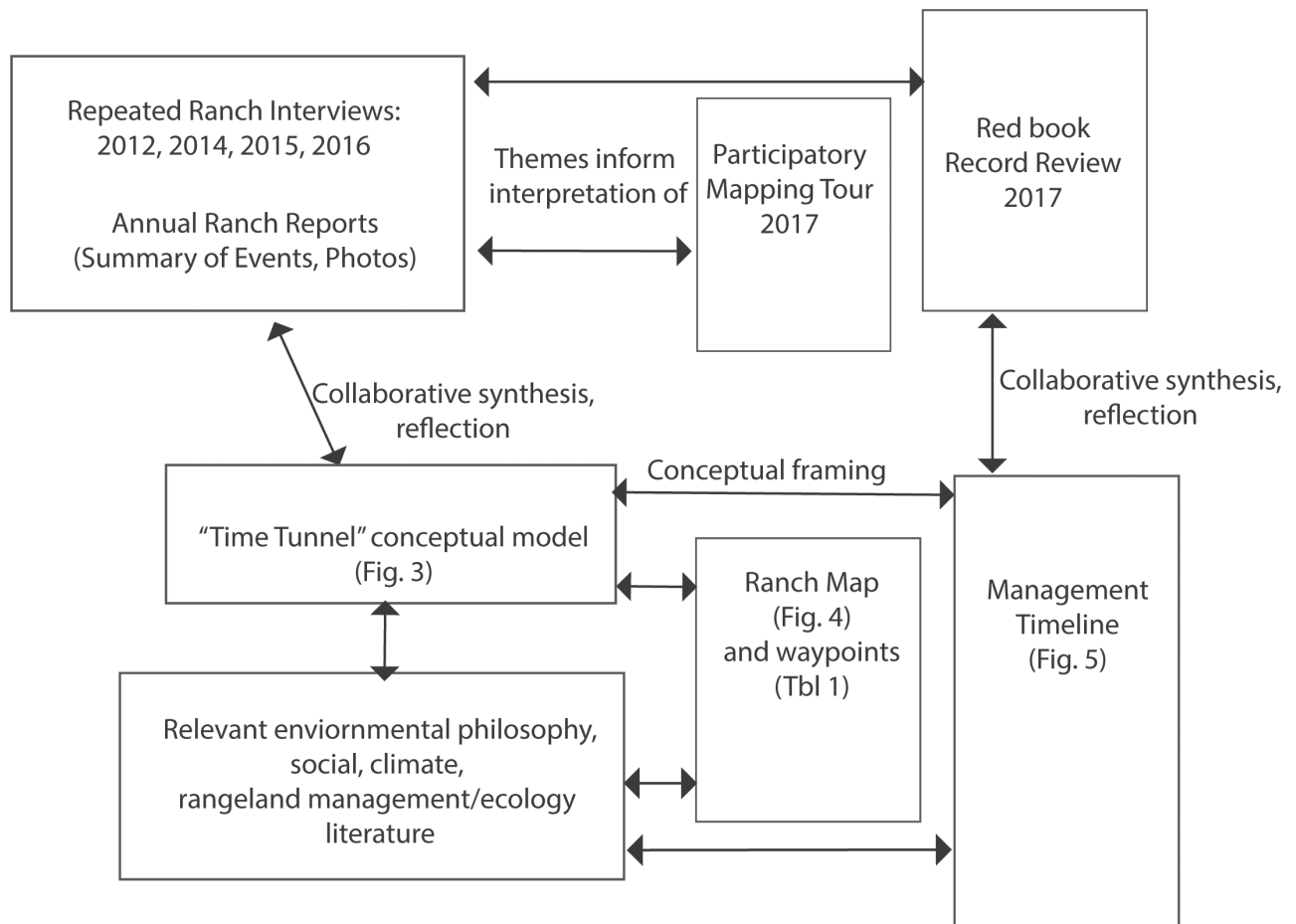


Fig. 2. Flow chart of collaborative methods, including repeated interviews, conceptual modeling, records review, and participatory mapping.

and romanticized in film and popular literature. But the multidimensional social and ecological experience, or “meaning making” of the contemporary commercial rancher, is underexplored, though not entirely absent (e.g., Grissom and Steffens 2013) in research (Sayre 2004). In this article, we address a key gap in the above ranch decision-making literature: a western Great Plains rancher’s mental model of how ranch systems operate and how ranchers make decisions. Our specific research objectives were to:

1. Describe the rancher’s mental model for ranching-system decision-making, including a description of how social and ecological aspects of ranching interact, and the rancher’s goals and information sources.
2. Describe ten years of his decision-making relative to spatial aspects of rangeland ecology, through a participatory mapping exercise.
3. Describe ten years of his decision-making in time, through a ranch management timeline.

Following the findings summary, we discuss how these processes inform ranch adaptation to social, ecological, and climatic drivers of change at multiple scales. We also discuss implications for other ranchers and for members of the conservation and research communities seeking to enhance their collaborations with ranchers.

Methods

Methodology

This is a single case study examined using case study methods (George 2005; Yin 2006). We also follow the qualitative tradition of participant/researcher collaboration which attempts to extend research decision-making to participants throughout the research process (Lincoln and Guba 1989; Merriam 2002; Jaggar 2015; Sprague 2016). We recognize that social research is a meaning-making process for both researcher and participants (Charmaz 2006). This work was conducted as

Established: 1995

Location: East of Grover, Weld County, Colorado (pop. 137).

Elevation: Headquarters: 1590 m; escarpment: 1650 m

Operation type: Cow-calf

Grazing resources: 1,092 ha of native and restored shortgrass steppe, including grazing permit on Pawnee National Grassland; 526 ha dryland forage crops.

Owner background: Experience in hotel management, finance, and construction.



Box 1: Profile of the case study. The ranch spans an 60 m escarpment and maintains a small population of limber pine (above).

a partnership with the view that curious conversation and critical self-reflection can lead to a deeper understanding for both parties. Data collection involved conventional semi-structured interviews and ranch tours over six years, following the tradition of narrative inquiry that investigates change in subjective experience with repeated interviews (Merriam 2002). This was combined with iterative collaborative synthesis, researcher-rancher discussion, review of the literature, and reflection (Charmaz 2006). Recognizing that our own subjective experiences influence our interpretation of the qualitative data, we work to improve credibility of the results through prolonged engagement with and “thick” descriptions (or detailed descriptions and data displays) of those data and peer-checking processes (Lincoln and Guba 1985; Opie 1992).

Data Collection and Analysis

Research for this project was conducted under Colorado State University IRB Protocols 10-829H, 11-3178H, and 12-3381H. We used an iterative process of data collection and interpretation (Fig. 2). Rancher S responded to a research invitation letter in the late spring of 2012, and Researcher T conducted a semi-structured interview and on-ranch tour with him that summer. Additional interviews, covering ongoing ranch decision-making, took place from 2014 to 2016. Each year Rancher S also made available an annual ranch report. This was a packet of photos, including photo monitoring of rangeland vegetation and wildlife, and a summary of yearly events.

To address our first research objective regarding rancher decision-making processes, Rancher S drew his mental model of the ranch system into a conceptual diagram, and we examined notes and transcripts from previous interviews to build out these concepts more fully in relation to rancher goals and information sources.

To address our second research objective regarding decision-making in relation to ranch system ecology in space, we conducted a participatory mapping activity in the fall of 2017. Researcher T recorded Rancher S’s description of important locations on the ranch while using a GPS device to waypoint coordinates at each tour stop. We reviewed these waypoints and compiled key location descriptions into a final map and legend.

To address our third research objective, regarding how decision-making occurred over a decade on the ranch, we synthesized interview themes with notes from Rancher S’s annual “red books,” the pocket-sized diaries of annual ranch records. These books included notes on vegetation production, wildlife, cattle and markets, stocking rate and financial records, and weather monitoring data from 2007 to 2017. We organized observations in these records and the interviews into a table via the “time-tunnel” conceptual model of ranch decision-making, including changes in ranch management philosophy, weather, grazing management, ecological observations, and profitability outcomes. We displayed trends in those indicators in a graphical figure. In our final meeting, we reviewed our initial findings for accuracy and reflected on the lessons learned over the past six years. We also discussed recent rangeland management and climate change literature to interpret forthcoming challenges for the ranch relative to management history.

Results

Conceptual Model for Ranch Decision-Making

Ranch decision-making takes place in a complex environment through interrelated and interacting social, biological, and climatic processes at multiple scales. Rancher S’s management goals, information sources, and mental model of decision-making provide insight into his interpretation of this context on his specific ranch, which has specific ecological and historical dimensions (for additional details, see Box 1).

Goals and Objectives. Rancher S identified five “principles of a rancher” that define his overall goals for the ranch. These are (1) “produce safe and wholesome beef,” (2) “be socially responsible with environmental stewardship of all natural resources,” (3) “maintain and enhance wildlife and plant community biodiversity through appropriate grazing management,” and (4) “protect human rights of usage on the property through due diligence,” and (5) “be economically viable.” He summarized his ethical responsibility to a ranch-sale ecosystem:

The rancher has responsibilities to our food and their food. Their food means that of all non-humans, below, on and above the soil. The rancher is responsible for the microbes, the plant community, the wildlife and livestock. He [*sic*] is also responsible for the well-being of humans on the ranch and connected to the ranch through the food system, and public and private lands [. . .] I can list 72 species from the lowly dung beetle to the magnificent Golden Eagle, including three of interest—prairie dogs, mountain plover and sharp-tail grouse, each with their own habitat requirements being accommodated on my ranch, a postage stamp size of land in the grand scheme of the environment.

The approach described in these principles shaped management decision-making as an overarching goal, but Rancher S’s position as the primary agent of change on the ranch is challenged by external factors.

Sources of Information. The source of information Rancher S used to make decisions are connected to his identity and life experiences, including early life experiences. Rancher S spent time on his uncle’s Montana farm/ranch in his youth, where he observed manager

adaptation to drought, grasshopper outbreaks, and variable markets. He noted his grandmother’s response to low wheat prices during the Depression: “They hauled the wheat in and it was no value. So, they hauled the wheat back out and she ran chickens and ducks.” He also recalled adjusting to insect populations: “We had a grasshopper outbreak, you took advantage of it. I was the turkey herder as a kid. The turkeys ate the grasshoppers and we sold the turkeys.”

These experiences taught him to “work with what you have” in variable weather conditions like those of the past decade. Growing up, Rancher S was also influenced by time spent in what is now the Bob Marshall Wilderness with friends, and by observations of environmental management in northern and western Montana in the 1940s and ’50s, including pest control and the impact of the mining industry. These experiences shaped his awareness of various components of ranch ecosystems, and also his tendency to prioritize wildlife conservation. He spent much of his working career in hotel management and construction before purchasing his current ranch in the late 1990s. Together these experiences framed his approach to ranching, including his identity as an outsider from traditional multigenerational ranching culture.

During the interviews Rancher S described how he employed weather forecasts—seasonal forecasts provided by the National Atmospheric and Oceanic Administration (NOAA) and by a private consulting group—in his decision-making. He watched the El Niño–Southern Oscillation updates carefully to inform “thinking a season ahead.” In the fall he typically conducted an inventory of the herd condition. At this time, seasonal weather predictions informed how he planned for winter expenses and culling. Higher probability of a dry spring indicated greater chances of limited summer forage production, and Rancher S would then prepare to lower cattle numbers by selling older cattle. By late spring, stocking rate numbers were typically set for the grazing season, but Rancher S would then begin to scout for affordable hay, and continue to look ahead for fall and winter market and weather forecasts in case prices increased.

For rangeland management information he turned to USDA’s Natural Resources Conservation Service (NRCS) and peer-reviewed literature, including the manager-targeted journal *Rangelands*. He also studied holistic resource management concepts (Savory 1983).

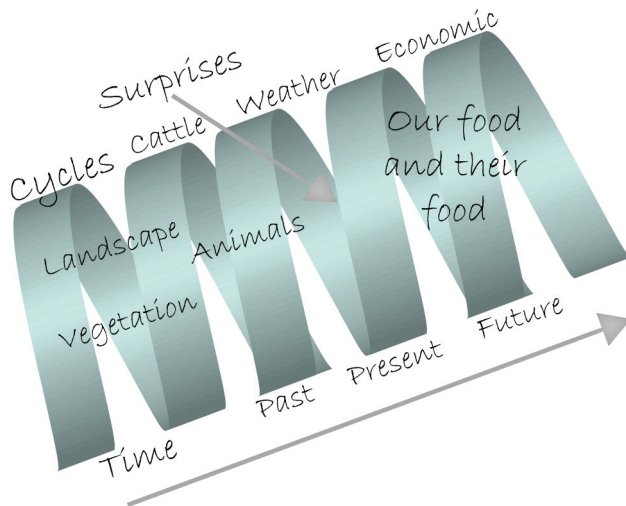


Fig. 3. Rancher S's conceptual model of ranch management links five dimensions of ranching: landscape and soils, vegetation (domestic and wildlife), economic and weather cycles, and "surprises" over time. This conceptualization guided development of the map and timeline.

He frequently attended policy as well as ecology and conservation conferences, and exchanged information with others in the industry during weekly trips to regional livestock auctions. He cited neighbors and employees as sources of information, and was observed collaborating and sharing information with neighbors, but he explicitly rejected many ranching traditions such as season-long continuous grazing and marketing strategies, as well as views of what comprised a "successful rancher," instead identifying as an outsider. Rejecting these traditions was part of his position outside the mainstream local ranching community, and was influenced by the fact that he purchased his ranch later in life and was not brought up in the local community. He relied heavily on industry and market information gathered browsing the internet.

The "Time Tunnel" and Multiple Dimensions of Ranching. Ranching goals and information sources inform decision-making within a complex context of ecological, economic, and climatic processes. Rancher S suggested these processes interact with one another in an iterative, progressive manner. These relationships are illustrated by his "time tunnel" (Fig. 3). The conceptual model includes five "dimensions" of ranching, a series of categories arranged from least to most dynamic, with indication that these cycles connect in an iterative, progressive nature over time. This order also indicates the

rancher's perceived level of agency in each dimension. Rancher S noted that relationships among these dimensions and feedback across scales move forward continually. He perceived ranch decision-making to involve dynamic, "living" processes at multiple scales, from the pasture and individual human or animal, to the local, regional, and global scales over the decades of a manager's tenure. He described these dimensions as:

1. **Landscape and soil.** Soil resources shape the potential of the landscape and agricultural production. Static soils properties are shaped by climatic, geological, and ecological processes over long periods of time, and by management and biological processes in the shorter term.
2. **Vegetation:** Diverse vegetative communities span native rangelands and "go-back" lands once used for farming across the ranch. In this slow-changing, semiarid rangeland ecosystem, native and introduced vegetation communities thrive where the land is not suitable for tillage.
3. **Animals:** Rancher S recognized that wildlife, domestic livestock, and working animals have their own behaviors and cultures, which interact with weather, topography, and plant and soil communities to shape habitat and production outcomes through nutrient cycling and diet selection.
4. **Anticipated external dynamics** or "cycles": This dimension encompasses the ever-changing influences of external drivers that managers have no control over, such as climate, weather, and economic dynamics, but which he can anticipate through relatively interpretable patterns. Rancher S sought to understand and interpret these "cycles" to make adaptive and forward-looking decisions considering the historic range of variability. This included watching short-term and seasonal forecasts, as well as tracking market reports and cattle prices carefully.
5. **Unanticipated external dynamics**, or "potential surprises": Borrowing a term from Joyce et al. (2013), Rancher S reserved a dimension for the unexpected and complex influences of policy and regulation, climate change, extreme weather events, and dramatic market shifts that shape the broader processes of interconnected earth and social systems. National economic dynamics, such as the recession of 2008, changing consumer demands, and trade policy also influence this dimension.

Taken together, these dimensions illustrate Rancher S’s whole-ranch view of ranch dynamics. An excerpt from Rancher S’s notes on the strategic ranch decision to implement year-round calving illustrates how these dimensions interact via a list of risks he is trying to manage:

The first benefit [of year-round calving] is selling calves more than once a year which means additional cash deposits into an account [compared to] only a single deposit with traditional single calving season. This strategy helps reduce risks related to late winter and or spring catastrophic storms; annual price cycle impacted by supply and demand; seasonal and/or full [yearlong] drought; selling price impacted by economic correction; political action and/or reaction at local, national, or international levels.

Thus, connections between the landscape, plant, animal, and human communities, including broader political and climatic dynamics, shape the context of his decision-making.

Mapping the Ranch

Results of the participatory mapping exercise, conducted in 2017, provide insight into the spatial aspects of the ranch decision-making conceptual model. They illustrate the location and connectivity of specific plant and animal species, aspects of ranch topography, and management legacies on the ranch (Fig. 4, Table 1). The results also demonstrate the rancher’s growing ecological knowledge and observations over time. Rancher S used place-based knowledge, ocular observations, and photo monitoring to make decisions about stocking rates, grazing systems, wildlife management practices, and forage cropping systems across the landscape (e.g., waypoint 1 and waypoint 3). The map indicates where Rancher S observed the influence of variable weather and drought on plant species composition and forage production over time (e.g., waypoints 4, 11, 19).

Notably, “go-back” land, areas that were once farmed and that have returned to rangeland vegetation, extended across a number of old homesteads that were consolidated on the ranch. Some of this area was replanted in the mid-20th century by federal programs in the Soil Conservation Service (waypoint 11). Federal conserva-

tion programs continue to influence management of lands enrolled in the Conservation Reserve Program (CRP)(waypoint 16), as well as through contracts in the Conservation Stewardship Program (CSP), which shape grazing management and ranch infrastructure across the deeded rangeland (e.g., waypoint 1). During the 2017 ranch tour, Rancher S noted that this income is important to him and thus these programs contribute substantially to his decision-making. He noted shortgrass-dependent wildlife communities (waypoint 2), and plant species observations, including notes about woody species (waypoints 8, 10, and 14). Grazing on the federal Pawnee National Grassland (waypoint 3) allotment is administered by the USDA–Forest Service, via the local grazing association. The map illustrates wind energy development (waypoint 15) and the proximity to the local rural community (waypoint 13).

Changes in Decision-Making Over Time

We used the concepts from the “time tunnel” model to organize ranch-system events, identified in interviews and in Rancher S’s records from 2007 to 2017 in graphical format (Fig. 5). The timeline follows a relatively wet period in 2009, followed by an intense flash drought in 2012 (Otkin et al. 2016), the associated recovery, then another precipitation spike throughout 2014–2015. We overlaid Rancher S’s annual rainfall observations with observed relative forage production (bars, Fig. 5) to specify cool-season (green) and warm-season (tan) productivity each year. These vegetation production estimates informed changes to stocking rates relative to a benchmark stocking rate of about 200 head across the ranch.

Rancher S’s ecological observations include patterns in insect, plant community, and bird characteristics over time. He noted that the important forage grass blue grama (*Bouteloua gracilis*) senesced early in 2009 and 2017. He observed weather impacts from drought, hail and blizzards, and wet periods. The magnitude and timing of these events created their own challenges for the cow-calf operation, and compounded stress from previous weather events and market conditions. For example, forage resources were scarce during the 2012 drought, as cattle prices were in “disarray.” The next spring, in 2013, a “killing April storm” led to numerous calf mortalities. That summer, low air quality impacted livestock health, as dust rose from increased oil-and-gas-industry-related traffic on local gravel roads.

Table 1. Qualitative descriptions of each waypoint in Fig. 4.

Waypoint	Description
1	Pawnee National Grassland allotment; most of pasture previously homesteaded; go-back area dominated by needle-and-thread grass (<i>Hesperostipa comata</i>).
2	Prairie dogs (<i>Cynomys ludovicianus</i>), burrowing owls (<i>Athene cunicularia</i>), and golden eagles (<i>Aquila chrysaetos</i>) observed here.
3	This shortgrass area (<i>Bouteloua gracilis</i> and <i>Bouteloua dactyloides</i>) typically grazed with pairs; season-long, continuous grazing at moderate stocking rate.
4	During 2012–2013, drought and grasshoppers lowered grass production here (noted from repeated photo points at this fenceline contrast). These pastures were deferred those years. Observed drop in western meadowlark (<i>Sturnella neglecta</i>) and lark buntings (<i>Calamospiza melanocorys</i>) in 2013, but observations increased in 2016. “Grassland birds are the first line of defense against grasshoppers.”
5	Small draw coming off the bluffs runs with water in a large storm. Observed skunkbrush (<i>Rhus trilobata</i>), roses (<i>Rosa arkansana</i>), juniper (<i>Juniperus scopulorum</i>), and subshrubs (e.g., <i>Artemisia frigida</i> and <i>Gutierrezia sarothrae</i>) expanding in this area of the ranch.
6	Little bluestem (<i>Schizachyrium scoparium</i>) observed here “if we get moisture.”
7	Recycled tires provide windbreaks for cattle near water tanks.
8	Observed four-wing saltbush (<i>Atriplex canescens</i>) cycle here, including booms in 1999 and 2017.
9	A patch of western wheatgrass (<i>Pascopyrum smithii</i>) near winter feeding area.
10	Chokecherry (<i>Prunus virginiana</i>) and juniper (<i>Juniperus scopulorum</i>) carve out a living here. “We have to adapt to what nature gives us.”
11	Go-back area was seeded into crested wheatgrass (<i>Agropyron cristatum</i>) in the 1950s by the Soil Conservation Service. This area is used for early spring pasture. Near the edge of the escarpment limber pine (<i>Pinus flexilis</i>) provide habitat for mule deer (<i>Odocoileus hemionus</i>) and porcupine (<i>Erethizon dorsatum</i>).
12	Mountain mahogany (<i>Cercocarpus</i> sp.) at the top of the escarpment. “We need rain.”
13	Scenic overlook
14	Rubber rabbit brush (<i>Ericameria nauseosa</i>) observed here. It is not preferred by cattle.
15	Wind energy development is a prominent feature on the ranch.
16	CRP ground and, hopefully, sharptail grouse (<i>Tympanuchus phasianellus</i>) habitat. Grazed during drought under Farm Service Agency Emergency Haying and Grazing program.
17	Forage crops are an increasingly important source of feed for cattle.
18	Old calving pasture is an area with the “most room for improvement” on the ranch.

Rancher S’s operational strategies changed in relation to weather and ecological dynamics. From 2007 through 2011, he ran a relatively conventional commercial cow-calf operation, with one calving window in February, and a rotational grazing system involving pasture rotations of short duration (<2 weeks) with one herd of cattle on pastures of a half or full section (640 acres). He was influenced by Holistic Management concepts through reading and workshop attendance (Savory 1983), and also worked with the USDA-NRCS staff to plan grazing and conservation practices. During this time he engaged in more “cattle trading”—buying and selling mother cows throughout the year across a group of three local livestock auctions. During the drought of 2012, Rancher S wholly abandoned his rotational grazing strategy. He

“opened all the gates,” providing cattle access to multiple pastures at once, culled his herd deeply, purchased off-ranch forage, and put calves on dairy cow “foster mothers” to reduce stocking rates and thus forage expenses. Post-drought, he gained access to more acres of forage crops, and grazed those while deferring native pastures for drought recovery. Eventually his cattle-trading approach led to a flexible “year-round” calving, exactly the opposite of the tight calving windows of conventional cow-calf operations. This enhanced his ability to flex stocking rates with variable weather, via selling “packages” of 20–40 pairs or calves at a time. By 2015 and 2016 he moved cattle around the ranch (on and off farm ground) to take advantage of spatial variability in rainfall and forage production. He deferred several pastures

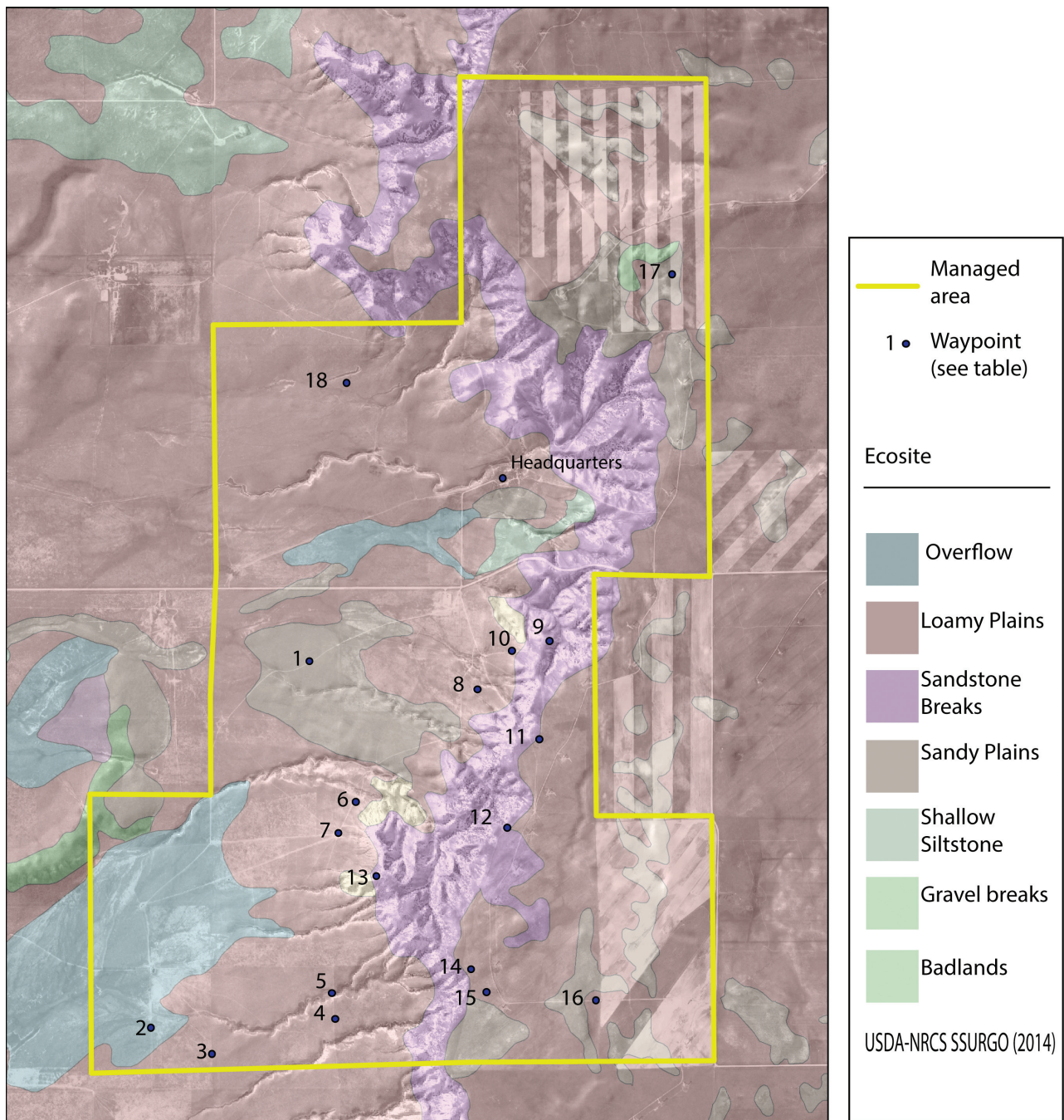


Fig. 4. A co-produced map of the ranch illustrates the spatial and ecological dimensions of ranch decision-making across ecological sites (source: SSERGO Database). Qualitative interpretations of these locations are indicated in Table 1.

to promote desired diverse species composition and to “stockpile” native forage.

His profitability outcomes (categorized as “turning a profit,” “breaking event,” or “lost money”) are indicated on Figure 3 for each year, along with cattle market observations. For example, poor profitability in 2013 reflected the legacy of the 2012 drought and the combined 2013

blizzard-and-dust impacts on the calf crop, while 2014–2015 was an exceptionally unusual period for beef prices, with prices climbing throughout 2014 and into 2015. In our 2016 interview, Rancher S discussed the challenges of maintaining a low-input operation and the benefits of certain costs, such as hiring a ranch employee to cover physical tasks he could no longer accomplish.

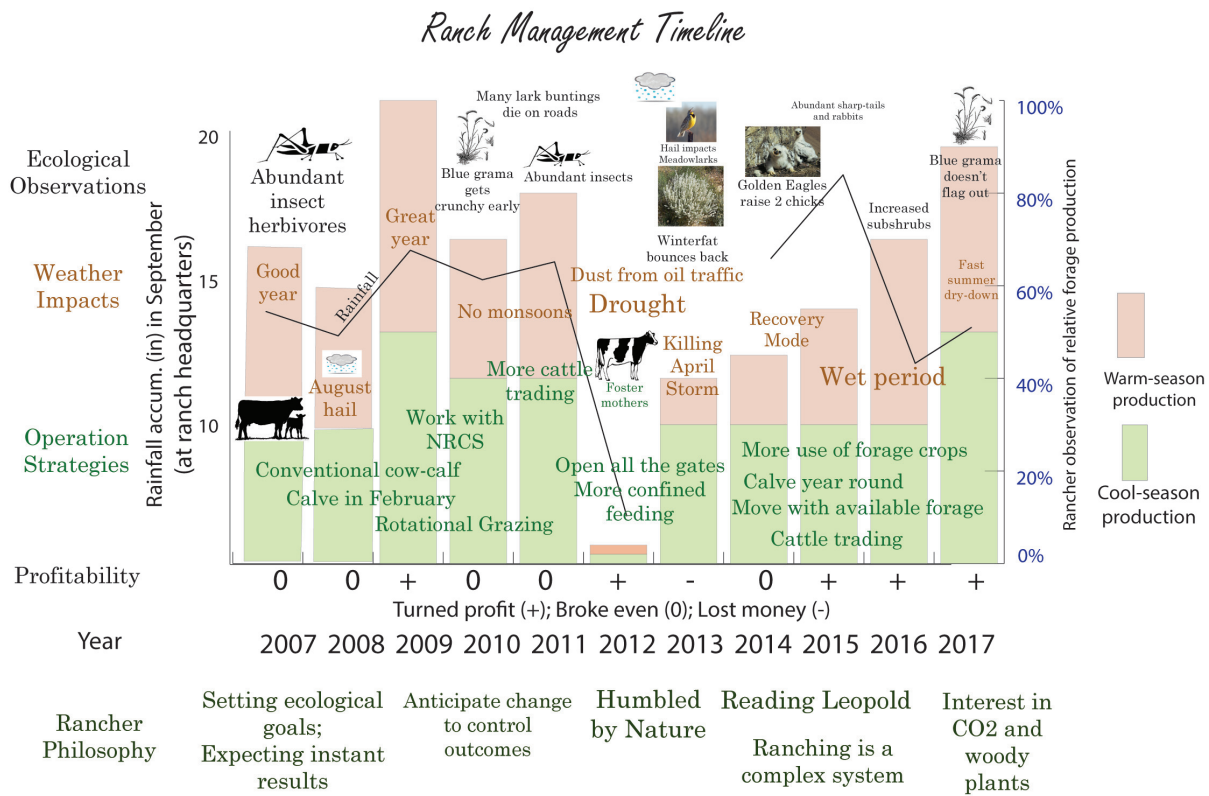


Fig. 5. Ranch management timeline was compiled from rancher “red book” diaries. It is organized in term of the multiple dimensions of ranching (Fig. 3). Ecological and weather observations over time shaped operation strategies. Profitability outcomes resulted from climatic, economic, and social changes. Rancher philosophy shows a notable change following the 2012 drought. Bars reflect relative cool- and warm-season forage production as recorded by the rancher.

“You’ve got to spend money to make money and you’ve got to have luck.” In acknowledging the need for luck, he recognized the role of uncertain markets and variable weather in shaping outcomes.

Changes in Rancher S’s management philosophy during the study period were largely driven by the experience of the 2012 drought and the lasting effects through 2013. These changes centered on how Rancher S saw himself within the “time-tunnel” of the ranching system, and how much agency, or control, he felt as a manager. After over a decade of management, in 2017, Rancher S described his approach as a “consultant mindset.” At this point in time he was aware of the importance of ecological goals, for example, managing plant communities for reference conditions based on NRCS-provided ecological site descriptions. However, he still expected “instant results” from his efforts. He anticipated a certain capacity to “control” ranch outcomes based on prior planning and data interpretation. But the combined drought, dust, storms, and low cattle prices of 2012–2013 put incredible stress on his business and

on him personally. He was “humbled by nature.” This experience, and subsequent reading of Aldo Leopold’s writings, reshaped his self-image from manager or “controller” of the ranch system and ecological community to, quoting Leopold, “just plain member of it” (Leopold 1949). This shift in self-image from a *manager* to *member* of the greater ecological community following the 2012 drought coincided with (1) recognition of his lack of ability to control ranch outcomes, including species composition, in the short term; (2) choices to increase ranchwide flexibility in grazing and herd management; (3) interest in the effects of CO₂ increases on plant community composition; (4) discursive emphasis on wildlife conservation goals. (“I was thinking like a consultant and trying to get back to the reference community, trying to steward the plant community. Now I think, ‘Just survive it, so you can continue.’”)

Overall, this shift in self-image corresponded with a growing awareness of the complexity of ranching systems. He said he also had an increased interest in environmental and conservation activism. At one point late

in 2017 he said, “My wife thinks I am an activist.” Rancher S worked to ensure that a portion of the ranch was covered by a conservation easement, which will restrict development beyond Rancher S’s tenure on his ranch. He described plans for the future of the ranch ownership this way:

The ranch is my dream come true. My children have their lives and dreams and are not expected to continue my dream any more than I continued my father’s occupation as a merchant. Besides, ranching is my third occupation since graduating from DU [University of Denver] in ’59 with a major in HRM, Hotel Restaurant Management. Then in ’95 HRM became “Holistic Resource Management” of the land as defined by Aldo Leopold. I’m still in the occupation of furnishing food and lodging, just a different clientele.

In the later years of the study, Rancher S observed increased subshrub cover across the ranch (e.g., Fig. 3, waypoints 8, 10, and 14). This led to him to research and explore climate change dynamics and to peer-reviewed work on the impacts of rising of atmospheric CO₂ in the area.

Findings Summary

In sum, our longitudinal qualitative approach examines ranch decision-making situated within a specific social and ecological context. Together, the decision-making conceptual model, social-ecological ranch map, and decision-making timeline provide insight into several complex aspects of management at the ranch scale. First, the conceptual model describes how ranch decision-making takes place within numerous interacting, dynamic social and ecological processes. It also makes visible the various levels of agency, or ability to act, within those dimensions. Rancher S does not see ranch system relationships in reductionist terms but as subsystems within a whole-ranch social-ecological system, itself operating within larger systems. Second, the map illustrates how the rancher perceived the spatial variability in management legacy, weather, and ecological characteristics. He developed and applied this evolving place-based knowledge of species composition, wildlife habitat requirements, and temporal dynamics in rangeland production as he selected management

priorities, and strategies for grazing and stocking rate. Third, the timeline shows a long temporal window of this multidimensional ranch decision-making. This allows us to see stocking rate adjustments among years (bars on Fig. 4), and also distinct shifts in both management philosophy and grazing strategy. Here, weather, market, and cattle outcomes intersect with the rancher’s learning process to produce pivotal changes in how he viewed his relationship to the ecosystem. Finally, the timeline documents the rancher’s growing recognition of shifting management baselines, including through the effects of rising CO₂ and warming effects on plant species composition and forage quality. This led to an emphasis on flexible management, conservation goals, and forward-looking climate and weather adaptation informed by recent rangeland ecology research (specifically Morgan et al. 2011; Joyce et al. 2013; Grissom and Steffens 2013; Mueller et al. 2016; Derner et al. 2018; Perryman et al. 2018).

Discussion

Ranch decision-making research has documented the characteristics of ranchers and ranches that predict conservation and production innovation adoption and drought planning (Didier and Brunson 2004; Kachergis et al. 2013; Lubell et al. 2013), but demographic variables explain little of the variance in this decision-making (Ghajar, Fernández-Giménez, and Wilmer 2019; Kelley, Fernández-Giménez, and Brown 2013). Sayre (2004) suggested that qualitative research is needed to enhance our understanding of rancher decision-making experiences and needs, which inform the development of more useable rangeland ecology research (Sayre et al. 2017). Qualitative research intends to develop new theoretical approaches, for example, middle-range theory, which is not necessarily widely generalizable but can enhance future evaluations of the broader ranching population (Charmaz 2006). Limited as they are to a single case, our data from six years of ongoing collaboration covering ten years of management history allowed us to develop and explore a conceptual framework for ranch management complexity. Below we consider how this contributes to a larger body of ranch decision-making research. We also discuss how it might be used by other ranchers, and by conservation and research community members seeking to strengthen their collaborations with ranchers.

The rangeland management literature offers various conceptualizations of ranch decision-making, including the model presented in Lubell et al. (2013). Our framework offers a rancher's view of these same social and ecological interactions, framed from the lens of his capacity to manage plant, animal, and human interactions across scales. Many of the components of the two models (Figs. 1 and 3) are similar, but the rancher's model includes a different conceptualization of time and uncertainty, a more explicit organization of levels of agency for managers across system dynamics, and a less explicit consideration of sociocultural values and psychological processes (though these are expanded on in the timeline, Fig. 5). This "insider's" view confirms and expands upon the *etic*, or outsider's view, synthesized from the literature on economics, social psychology, and rangeland ecology by emphasizing the situated, contextual, and dynamic aspects of rancher knowledge and decision-making (Haraway 1988). It also highlights the particular ways that relationships between rancher and ranch systems change over time. Given these contributions, our framework could inform future survey research regarding how and when ranchers develop a sense of agency in their decision-making, how managers' perceived relationships to ranch ecosystems develop and change over their tenure, and the role of market and weather variability on decisions within and among years. These concepts could contribute to our understanding of decision-making across sectors and regions when examined with quantitative methods such as those from social network research used by Levy, Lubell, and McRoberts (2018) to understand systems thinking in the mental models in California's sustainable agriculture sector. They might also prompt ranching social science to move beyond psychological phenomenon driving ranch decision-making to consider larger structural and social scales.

Lessons learned for the rancher over the study period may provide other managers, particularly other first-generation ranchers, with insights into the process of learning to operate a ranch and address drought and market variability. While Rancher S grew up around agriculture, he bought his own ranch later in life and developed information networks and management strategies without support from a larger family network. For managers, the study highlights the social and ecological factors that pushed Rancher S to change and adapt over the years, as well as the opportunities provided by creativity and flexibility.

Rancher S's experience is also about learning

and developing a more nuanced and explicit ethical relationship to the ecosystem. Having been "humbled by nature" in the 2012 drought, despite extensive proactive planning, Rancher S actively worked to become more flexible and to reevaluate his self-image relative to livestock, vegetation, wildlife, and food production. He said he developed an appreciation for systems thinking over linear thinking, and an enhanced sense of responsibility to the ranch ecosystem. This turning point recalls Leopold's "Green Fire" moment, described as the instant a young Leopold watched "a fierce green fire dying" in the eyes of a wolf he was exterminating, at once realizing "something new" about his ethical relationship to the landscape (Leopold 1949). Rancher S's turning point following the "humbling" 2012 drought was less dramatic, but was personally significant and impactful on his approach to ranch management. He held on to the ranch during a financially and emotionally challenging period, maintained a passion for his work via conservation and stewardship goals, and remaining committed learning and adaptation. An important lesson for Rancher S was to face the reality of shifting baselines, or to "not manage for 1880," meaning that he focused his efforts of forward-looking opportunities rather than maintaining nostalgia or attempting to recreate or recover past conditions, as discussed by Perryman et al. (2018). Ongoing review of financial monitoring, grazing monitoring, photo point monitoring, and other forms of monitoring helped him evaluate and apply lessons from these challenges. For other managers, this illustrates the complex process of recognizing when a strategy or philosophy is not producing the desired results and adjusting that approach, as also noted by Grissom and Steffens (2013) and in the adaptive management literature (Holling and Meffe 1996).

For researchers, the study provides an example of collaborative development of rangeland management knowledge. Here the researcher and rancher worked together to document and interpret ranch decision-making. Together we gathered and constructed knowledge of the multiple interacting drivers and outcomes in the case study. We developed a strong working relationship that allowed us to investigate ranch decision-making challenges, evaluate past successes and setbacks, and discuss how new ideas, including those in the rangeland ecology and climate change literature, related to these processes. This led to increased mutual trust and understanding, and to opportunities for critical self-reflection that fed back into our respective management and research approaches. We offer this methodology,

and activities such as repeated interviews, participatory mapping, historical record review, and conceptual model development, as a potential boundary-spanning approach for rangeland and ecology research and ranching communities. It is inclusive of researchers across career stages and backgrounds but may be particularly useful for early-career researchers in applied ecology fields.

Our data help communicate ranchers’ mental models to non-ranchers. Our study provides a window into a single ranch that can inform climate and weather professionals, consultants, university extension educators, wildlife conservation groups, and researchers seeking partnerships and collaborative opportunities with ranchers. Rancher S’s experience may not be widely generalizable to other ranches, but for these readers, our study illustrates how a conservation ethic is practiced on a working ranch, and how little agency the rancher felt to make change given stochastic market and weather events. The whole-ranch approach we offer is not novel or inclusive of broader community and cultural experiences (Webb 1931; Zimmerman and Larson 2010; Bennett 2017) but does attempt to continue a conversation about rural experiences and implications for rural people and landscapes. Our aim in this regard is to inspire curiosity in the rancher’s way of being and demonstrate the value of listening and co-learning in researcher-rancher partnerships. Every ranch is unique in terms of ecological and socioeconomic contexts (Kachergis et al. 2013; Roche et al. 2015; Wilmer, Augustine, et al. 2018).

Ranchers have diverse ways of knowing, and develop information networks, strategies and goals to suit personal, climatic, historical, cultural, and other ecological constraints (Wilmer and Fernández-Giménez 2015). They also operate in dynamic rural community networks that create and limit opportunity for learning, resource sharing, and mobility (Adger 2003; Arnold and Fernández-Giménez 2007). Our data focus on a case demographically typical of US primary rancher operators: Rancher S is an older white male operator with a moderate-sized (~200 head) operation (Horst and Marion 2018). Additional research on ranching experience across economic, racial, ethnic, gender, sexuality, age, and ability groups, and on how intersecting systems of social power shape environmental and livelihood outcomes in ranching communities, can contribute to social and environmental problem solving (Glaser et al. 2008; Zimmerman and Larson 2010; Collins and Bilge 2016). This may be more important in the future as US ranchers age and rural community

networks reorganize under dynamic climatic and economic conditions (Joyce et al. 2013; Marshall and Smajgl 2013; Polley et al. 2013).

Conclusion

In this study, we present the multiple dimensions of ranch decision-making and illustrate the application of that model in space and time. The results of our co-mapping and timeline development document the complexity of ranch decision-making, and how the rancher adapted management strategies and paradigms to dynamic ecological, weather, and market conditions. Rancher mental models provide insight into decision-making contexts that shape wildlife conservation, agricultural production, and economic outcomes. The rancher weathered, but was humbled and changed by, drought and swings in the cattle market during the study period. This single case study provides researchers, managers, and outreach and/or conservation professionals a window into ranchers’ decision-making processes that inform future collaborations.

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An Indigenist Theory of Health Advocacy

Regina Idoate, Michele Marie Desmarais, Brittany Strong, Anne Steinhoff, Lilly Tamayo, Gretchen Carroll, Chaulette DeCora, Cassie Rhoads-Carroll, Nicole Tamayo-Bergman, Camille Voorhees, and Victoria Hoyt

ABSTRACT—A circle of intergenerational and intertribal women worked on a unique community-based participatory research study, using art-based and Indigenous research methods in grounded theory to identify an Indigenist theory of health advocacy. The *Bundle of Seven Strands* illuminates ways of knowing, being, and doing that ground and inform a deeper understanding of Native American health advocacy. This study can bridge existing knowledge of Indigenous theories with a pragmatic theoretical framework that can be applied and utilized in situations that call for health advocacy in relation to Indigenous Peoples, places, and perspectives. Moreover, this theory can help health program developers and evaluators be explicit about their assumptions about how health advocacy can contribute to culturally appropriate and engaged wellness activities in urban Indigenous communities.

Key Words: art-based research, grounded theory, health advocacy, Indigenist, Native American

Background

Many know of Susan LaFlesche (Omaha artist and the first Native American medical doctor) or Wilma Mankiller (former principal chief of the Cherokee Nation and leading advocate for Cherokee healthcare and education systems) or Christi Belcourt (Métis community-based artist and advocate for lands, waters, and Indigenous Peoples). But few in the dominant culture hear about Native American women who walk softly every day in paths that lead us to healthier communities. We stand on the shoulders of such women as Diana Robertson (Cherokee grandmother and registered nurse), Rosalie St. Denis (Mother of the Métis Resistance), Angel DeCora (Winnebago artist and teacher), Josephine Nash (Winnebago mother of 12 and pioneer in Thurston County, Nebraska), Marita Growing Thunder (Fort Peck Assiniboine Sioux founder of the “Save Our Sisters” movement), Dr. Henrietta Mann (Cheyenne leader in education and founding

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Fig. 1. Indigenists, from left to right: Michele Marie Desmarais, Regina Idoate, Chaulette DeCora, Brittany Strong, Lilly Tamayo, Nicole Tamayo-Bergman, and Anne Steinhoff.

president of the Cheyenne and Arapaho Tribal College), and Marissa Vigneault (assistant professor of practice, modern and contemporary art). These relatives of ours give us strength and vision and we, Indigenists, share our story in honor of them.



Fig. 2. Embodied loom at the *INDIGENIST* exhibition in 2017.

Native American women have a rich history of being influential social forces and powerful advocates for health and wellness. Their efforts to defend tribal sovereignty, to preserve cultures, languages, and traditions, to protect Indigenous land rights and natural resources, and to humbly survive and thrive as part of a greater community are all unique to their identity as colonized Indigenous Peoples supporting health and wellness. The Indian Health Service and other agencies employ Native American women as nurses, community health representatives, health navigators, and prevention specialists that are envisioned to be advocates and educators within tribal communities. Health advocacy, however, extends beyond formalized healthcare work and into the everyday roles of grandmothers, mothers, aunties, sisters, daughters, and nieces (Moss 2015). Although Native American women's voices can inspire positive health and wellness change, the roles and responsibilities that they adopt as advocates are poorly understood and inadequately researched.

Artists and curators involved in *Woven: Grounding Feminist Thoughts and Practices in Omaha* recognized the arts as a way of attesting to Native American women's health advocacy work in our local community in the Great Plains. Inviting community members to sew fragments of red-hued used clothing into the structure of a house, co-curators of *Woven* established a gathering space for performances, discussions, and friendships that came alive in literal representations of advocacy. In 2017, with funding from the Omaha Creative Institute, *Woven* hosted a series of performative events, skill-sharing workshops, and outreach initiatives. Co-



Fig. 3. Woven Tapestry created by the embodied loom.

curators of *Woven* invited local Native American women advocates for health and wellness to create an exhibition that shared the perspectives of Native American women in our community. This exhibition, *INDIGENIST*, presented art that responded to the following question: *What does it mean to be an Urban Indian Woman who advocates for Native health and wellness in Omaha? What is your story?* Nine intertribal, intergenerational women and co-curators participated in *INDIGENIST*, sharing health advocacy stories through the arts and creating the space to explore local feminism, indigeneity, and health advocacy through the co-curation, exhibition, and investigation of *INDIGENIST* (Fig. 1).

On October 9, 2017, *INDIGENIST* opened. The exhibition continued for the month of November at a local university's Community Engagement Center. *INDIGENIST* included sculptures, poems, a speech performance, paintings, dolls, shawls, nests, beadwork, tapestries, moccasins, and more. *INDIGENIST*, free and open to the public, engaged visitors in a community-based participatory prayer and embodied loom (Fig. 2) weaving to create a woven tapestry that was also added to the exhibition (Fig. 3). The program incorporated abstracts written by presenting artists, summarizing the processes involved in creating the art, a description of the art work, and the significance of the art. *INDIGENIST* brought people of all backgrounds together to explore and engage in stories from Native American perspectives that took form in all mediums.

We follow in the paths of other Indigenous scholars who have advanced Indigenous ways of knowing, being, and doing through various mediums (Cajete 1994; Martin and Mirraboopa 2003; Barnhardt 2005; Wilson 2008; Bainbridge, Whiteside, and McCalman 2013). The contemporary narratives of *INDIGENIST* were exhibited within the specific context of a decolonizing,

postcolonial, performance space on Indigenous Peoples' Day and over the course of Native American Heritage Month. This exhibition provided us with data and opportunities for exploratory research in an area where an evidence base is lacking. Health advocacy is among the most difficult aspects of medicine to learn and teach, assess and evaluate, explore and research (Hubinette et al. 2017). Yet scientific evidence is expected to guide research-driven advocacy (Farrer et al. 2015). Some scholars suggest exploring advocacy by focusing on how characteristics in narratives and images are perceived by different audiences (Farrer et al. 2015).

Many scholars have presented understandings of health advocacy in relation to and across disciplines, including professional advocacy (Soklaridis et al. 2018), public policy (Conrad et al. 2019), and education (Freudenberg 2005). There are numerous existing theories, grounded in diverse worldviews and various disciplines, with relevance to health advocacy (Breuer et al. 2015). Although health advocacy has not been investigated from an Indigenous perspective, some scholars have advanced other Indigenous theories that can contribute to this field, including Felt Theory (Million 2009), an Indigenous feminist approach insisting on the inclusion of women's lived experience of pain and grief and hope and healing and Indigenous Wholistic Theory (Absolon 2010), which involves picking up our bundles, relearning, reclaiming, and reactivating the teachings and practices that bring us medicine. These scholars point to a responsibility for Native American women to live and practice within a framework that organizes and presents Indigenous knowledge. Our research specifically aimed to explore the process of health advocacy and what it means to be a woman who advocates for health on behalf of Native American people.

As Absolon (2010) explains, Indigenous theory is not developed or understood through reading or vicarious ways; it is a lived phenomenon. By making use of the tools of art, feminism, and indigeneity, we employed Indigenous and arts-based research methods to investigate the narrative construction and social presentation of health advocacy through dynamic artistic processes characterized by the continuous interaction of physically, mentally, emotionally, and spiritually related thoughts and behaviors. Visuals, like the *INDIGENIST* exhibit, can lift words, concepts, and themes into a lived experience involving all of the senses (Absolon 2010).

Indigenist artists-advocates and curators-researchers formed a research collaborative, aiming to explore

INDIGENIST as data and explain an Indigenist theory of what it means to advocate for Native American health and wellness, specifically in the areas of knowing, being, and doing. Knowing, being, and doing, widely used as a relational Indigenous research framework, honors and preferences Indigenous worldviews, knowledges, and cultural practices. Bainbridge, Whiteside, and McCalman argue that grounded-theory studies fit well with Indigenous research methods because, "as researchers, our ways of knowing and being are inseparable from our ways of doing, and all ways of doing make epistemological claims" (2013, 275). As Martin and Mirraoopo (2009, 210) explain, "we become tangible proof of our ontology and its construction of our Ways of Being and Ways of Knowing. That is, we are able to show (Do), respectfully and rightfully (Being) what we know (Knowing)." Thus, we sought to recognize and consider the advocacy process by examining how ways of knowing, being, and doing inform artworks that represent identity, roles, and responsibilities that influence the lived experience of Native American women as health advocates.

Methods

Gilbert et al. (2016) Aita et al. (2010), Barone and Eisner (2012), and McNiff (1998) acknowledge the arts as expressive ways to convey meaning and argue for more innovative and open-ended inquiry through arts-based research methods. Indigenous research methods also promote more qualitative, collaborative, community-based, participatory frameworks that ethically empower community members to become involved in the research to help ensure that research acknowledges context and worldview (Tuhiwai Smith 2013; Denzin, Lincoln, and Smith 2008; Wilson 2008; Chilisa 2012; Desmarais and Robbins, 2019). According to Denzin (2010), grounded theory is ideal for engaging in decolonizing research because this open-ended inquiry respects Indigenous knowledge systems. Although grounded-theory methods have limited generalizability, Bainbridge, Whiteside, and McCalman (2013) assert that "theory development grounded in data provides useful insights into the process for raising the health, well-being and prosperity of Aboriginal Australians," and we believe that the same can be true for Native American populations.

This study aimed to develop a substantive theory of

the essence of being an “Indigenist” as it relates to health and wellness advocacy in the urban Great Plains and as it evolves in a naturally artistic setting. To study *INDIGENIST*, a circle of Native American women sat down together with co-curators of the exhibition to engage in open dialogue and come up with ideas, much like what traditional Indigenous healers and western researchers often do. This process, similar to talking circles as described by Wilson (2008) or healing circles as described by Mehl-Madrona and Mainguy (2014), facilitated a unique style of communication with a structure that promoted exploration in an empathic, respectful, and supportive atmosphere. Employing an Indigenous research paradigm, all presenting artists and curators in *INDIGENIST* were purposefully recruited to participate in this study. With the exception of one artist who offered great blessings to the project but did not have the time to engage in the research, all participated in data collection and analysis and all are authors of this article. We formed a sacred circle of community to ask and answer questions through relational knowledge. Through a community-based-participatory-research approach (Israel et al. 2005), we came together to critically examine the stories within our circle of Native American women as told through many mediums. The story of one was not considered outside the story of the whole.

This study was reviewed and exempted by the Institutional Review Board at the University of Nebraska Medical Center. Methodologically, this study took a constructivist view, aiming to establish our work as a contribution to decolonizing research. In this way, we recognize both community and philosophy, the artists and the art, the researchers and the researched, in a reciprocal and intersubjective relationship of shared contributions to the knowledge developed. We implemented a strengths-based model of research, which created space for Native American women to share stories through art and notice and listen and analyze and interpret the aesthetic whole as a collective of artists and curators. A phronetic, visual and verbal, grounded-theory approach was used in the analysis of the overall exhibition. We consciously attended to the holistic, nonlinear, remote-sensing, local, place-based experience to develop a qualitative understanding of the creative process (Martinez 2010). We analyzed both visual and verbal data, which were exhibited publicly in *INDIGENIST*.

The visual data explored within our circle included all forms of art presented as part of the *INDIGENIST* exhibit: sculptures, prayers, poems, an oral lecture, paintings,

dolls, shawls, nests, beadwork, quillwork, tapestries, moccasins, and more. The verbal data we examined included all written abstracts and spoken words associated with the art presented as part of *INDIGENIST*. Our observations, symbol-based reflections, field notes, photographs, stories, theoretical memos, and sharing circle notes all contributed to this qualitative study, which followed a phronetic approach to constructing grounded theory (Bainbridge, Whiteside and McCalman 2013). All data were analyzed as part of the overall experience. Each of the following ten works of art included in the exhibition were analyzed as part of the aesthetic whole, by eleven presenting artists, four of whom also served as co-curators:

1. ***Native Fringed Dancing Shawls***

Medium: Shawls

Presenting Artist: Cassie Rhoads-Carrol—Citizen of the Cheyenne/Arapaho Nation

2. ***Indigenested***

Medium: Nests and Poems

Presenting Artist: Michele Marie Desmarais—Métis (Canada)

3. ***Josephine and Her Six Daughters; Amazing Women; I Paint with My Ancestors***

Medium: Paintings; Poem; Oral Reading

Presenting Artist: Anne Steinhoff—Winnebago Tribe of Nebraska

4. ***Insane thoughts of a sober mind—a variety of poetry readings***

Medium: Poetry; Oral Reading

Presenting Artist: Gretchen Carroll—Citizen of the Cheyenne/Arapaho Nation

5. ***Children of the Selu***

Medium: Dolls

Presenting Artist: Regina Emily Robbins—Cherokee Nation of Oklahoma

6. ***Continuing Tradition***

Medium: Oral Speech; Beadwork; Moccasins; Quillwork; Rawhide Woman’s Purse

Presenting Artist: Nicole Tamayo-Bergman—Sicangu Lakota

7. ***Imperfectly Perfect Moccasins***

Medium: Poem; Oral Reading; Moccasins

Presenting Artist: Brittany Strong—Algonquin of Pikwakanagan

8. *Stronger than Ever*

Medium: Oral Speech; PowerPoint Presentation
Presenting Artist: Lilly Tamayo—Sicangu Lakota

9. *Untitled 3.0*

Medium: Poem; Oral Reading
Presenting Artist: Chaulette DeCora (Cholly)—
Winnebago and Omaha

10. *Woven Tapestry*

Medium: Prayer; Weaving
Presenting Artists: Carolyn “Big Momma” Fiscus,
Victoria Hoyt, Camille Hawbaker, and Omaha
community members

One week after the opening of *INDIGENIST*, we reunited to sit in a circle around the works, contemplating the exhibitions and engaging in open dialogue about what we thought, felt, saw, tasted, smelled, and heard. We carved out space and time to reflect and reminisce and be mindful of all that was happening within and around the exhibition. This inspired memo writing, which helped us find deeper meaning in all that our senses took in. We discussed our observations and noted every idea, thought, conclusion, connection, and message that we experienced.

INDIGENIST was analyzed to generate a theory of what it means to be an urban Native American woman who advocates for health and wellness. All participants imparted wisdom, knowledge, and experience through works that embodied meaning and purpose. We were able to consider the varied parts of the exhibition in aggregate through open coding. This allowed us to shift our thinking from concrete descriptions of each piece to conceptual explanations of the whole by recognizing the process and the purpose. Our abstracts embodied intuitive knowledge that was brought to light through writing. Abstracts and accompanying artworks were considered and coded using focused, open, and axial coding techniques to expose general concepts and sort them into categories.

As we examined the exhibition, we shared insights and noted themes and patterns that guided us toward identifying categories that we could elaborate on. This led to the creation of theoretical statements. Our investigative process allowed the emergence of further analyses and selective coding, which led to the explication of theoretical and categorical relationships. Through selective coding we were able to determine the need to elaborate on Indigenous ways of knowing, being, and doing. Later, we used theoretical memo writing to expound on the vi-

sual and verbal interpretations of the exhibition through theoretical codes. We (artists, advocates, researchers, and curators) were the fundamental channel through which the inquiry process developed and data surfaced. We analyzed all artworks, performances, and abstracts related to *INDIGENIST* as primary data sources within the larger context of advocates’ status as a colonized people living in urban areas. Our stories were interpreted as one voice.

Our initial grounded-theory analyses of open coding acknowledged the themes that emerged from not only text in the abstracts or titles of the artworks but also the art as it was exhibited and performed. This resulted in nine categories and 71 codes. After sorting through a range of themes and patterns associated with the exhibition in response to the overarching question, we were able to refine our work through axial coding to produce seven categories and 45 codes. Concepts emerging from the data were organized into higher-level categories that ultimately comprised the Indigenist health advocacy theoretical model in the final selective coding process, which was produced from one main category, seven subcategories, and 41 codes. All categories and codes explain and support each of the processes of knowing, being, and doing for Indigenist health advocates.

Results

“Indigenist” was theoretically identified as the core category that encompassed Native American women’s identity as advocates. At the culmination of data analysis, we defined “Indigenists” as women who share adversity and strength from the past in an art of advocacy that weaves healing in the present into hope for a future with respect for Indigenous ways of being, knowing, and doing. In the aggregate, the core components of the theory interact to form the advocacy process, which is represented in a uniquely interwoven bundle that can be considered medicine. As Portman and Garrett explain:

Medicine is in every tree, plant, rock, animal, and person. It is in the light, the soil, the water, and the wind. . . . Medicine is something that happened 10 years ago that still makes a person smile when thinking about it. Medicine could be that old friend who telephones unexpectedly just because he or she wanted to do so. There is Medicine in watching a small child play. Medicine is in the



Fig. 4. *Josephine and Her Six Daughters*



Fig. 5. *Children of the Selu*

reassuring smile of an elder. Native Americans also believe that there is Medicine in every event, memory, place, person, and movement. Medicine could be an “empty space” if one knows how to use it. And there can be powerful Medicine in painful or hurtful experiences. Even such experiences offer the opportunity to see more clearly the way things connect and disconnect in the greater flow of this stream called Life. (2006, 459)

The medicine in this project came in many forms and although it may be found in the product of the exhibition, it is most alive in the process, in women’s immersion into sacred circle, and the creative process in the community. For example, sand paintings can be full of beauty, but the medicine of a sand painting for the Navajo people lies in the creative process; “the product has no worth” (Leuthold 1998). When work with a sand painting is finished, it is subsequently swept away.



Fig. 6. *Continuing Tradition*

Likewise, those involved in *INDIGENIST* found beauty and medicine not only in the thing created but also in the relationships among things, the balance established between the creator, the materials, and the created.

Linking art and aesthetics with collective identity and representation in this cultural context means that “art is not separate from what many perceive to be non-art” (Leuthold 1998). In the dominant culture of the West, the primary relationship between humans and art is that of collecting, owning, displaying, and viewing. This was not the case for those co-curating and presenting in *INDIGENIST*. This fundamental difference in how art is valued can be applied to how we approached art-based analysis. In the case of *INDIGENIST*, the centrality of the process was the focus for curators, artists, and researchers. Although the artworks were collected and exhibited aesthetically, the beauty, spirituality, and ethics of *INDIGENIST* were intertwined in the creative process.

Analysis of the exhibition was intimately linked to

the artistic process, which led to the identification of a framework for health advocacy, theoretically identified as the *Bundle of Seven Strands*. This framework, represented by seven final categories, articulates how advocates for Native American health and wellness experience knowing, being, and doing as “Indigenists.” Forming the main actions of the core phenomenon, to advocate, these seven strands of advocacy make up the process: Remember, Respect, Relate, Reconstruct, Reflect, Reciprocate, and Rally.

Remember

As one *INDIGENIST* artist abstract explained, “as Native American women, we inherited from our ancestors not only historical trauma but also great sensitivity, traits, and gifts. We are natural poets, writers and storytellers. We are natural beaders, weavers, and painters. We share

a deep appreciation for our relatives' experiences, which both informs and influences our creations." A high level of importance was placed on remembering who we are and where we come from. Artists expressed a need to remember all that was lost as a result of genocide and to recognize Native resilience and strength, to connect back to ancestors, to retrace roots, to learn more about relatives from the past, to become more informed about Native American history and all that Native peoples have endured to bring us to where we are.

All artworks were created in remembrance of relatives and ancestors, including corn, ravens, and rocks. *Native Fringed Dancing Shawls* serve as a way of remembering those who have earned respect. *Indigenest-ed* remembered our feathered relatives and those who nurture and protect us. Others remembered specific ancestors, identifying them in *Amazing Women* and even more specifically as *Josephine and Her Six Daughters* (Fig. 4). *Children of the Selu* dolls were made in remembrance of a grandmother making dolls in the image of the Cherokee women in her family (Fig. 5). The quillwork, beadwork, and rawhide work in *Continuing Tradition* remembered teachers and those that pass down traditional ways (Fig. 6). *INDIGENIST* served as a reminder of all that Native American people contribute to society, identifying artists, educators, scientists, and spiritual beings who hold life and pass on traditions and existence. The exhibition was a testament to the Creator and all creation, human and nonhuman persons.

Respect

Native Fringed Dancing Shawls metaphorically wrapped us all up, humbled us, and called us to show respect. This was embodied in the circle in many ways, such as acknowledging our elders, apologizing for speaking before them, praying and asking for permission, waiting patiently, listening attentively, embracing the uncertainties of the process, offering tobacco, smudging, and giving thanks. There was a grateful recognition that our projects began long before our acts of creation. Out of respect, artists acknowledged where their gifts came from. Artists spoke humbly about their own works and reverently recognized details in each other's work with sincere appreciation. Such humility was articulated in the moccasins that hung by the poem *Imperfectly Perfect Moccasins*. The creation process represented the respect that each artist held for Indigenous ways of being, knowing, and doing together with an understand-

ing of modern ways present in the dominant culture. This balance found among two almost opposing forces was embodied metaphorically as artists and community physically worked together to weave diverse fiber strands into one piece of fabric through the warp and weft of the *Woven Tapestry*.

The respect that artists and artworks demonstrated in *INDIGENIST* evolved into trust. A great deal of trust was required at every level throughout the project. In creating our art, we had to trust our sense of traditions, ancestors, relatives, the process of creating, and our own gifts. In organizing the event, co-curators had to trust each other and the artists. We had to trust one another to create and maintain a safe, respectful place for each person to interact with community, materials, and our own personal stories. In abstracts, *INDIGENIST* artists described "stepping into vulnerability and owning it," experiencing the "power of ambiguity" in recognizing that this process was its "own living precious thing." Artists described this as being "open to all possibilities, surrendering attachment to a desired outcome" or as "being a channel." Many shared a feeling of uncertainty and "abandoning oneself to the art."

INDIGENIST was co-curated with an open prompt in a vague nature, with no proper details, no expectations, no orders, no rubrics, and no judgment. Although at times this may have felt like a scary place to enter, into the unknown, the artists agreed that respect for one another and for the process offered just enough guidance, allowing creativity to flow into unexpected and unique results. Some artists described this as "amazing," "freeing," and "exciting." This sense of tolerance for ambiguity is exemplified in *INDIGENIST* poets' explanations of the creative process. One artist acceptingly explained that "a poem never fully writes the way you want it" and another explained how her poems materialize, elaborating "I can't believe the things that come out of my head, as if someone else had thought them up and they are just being channeled through me. Maybe some of them are my thoughts, maybe they are a combination of mine and all my ancestors that came before me." Together, as our abstracts attest, we learned to "embrace the uncertainty of the process," to rely on help from our ancestors and the Creator, and, in so doing, to respect the artistic process as it "took life."

Relate

As Lakota and Cherokee people involved in this project said, *Mitakuye Oyasin* and *Otsalanvli* (We are all re-

lated). We are all answerable to all of our relations, and this was the case for everyone involved in this project. We worked in relationship with one another and with our co-creators, our ancestors, our environment, our materials, and our questions. Within our circle were spiritual leaders and teachers and students, mothers and daughters, sisters, friends and colleagues as well as our Creator, ancestors and cottonwood trees, corn and sweetgrass, sinew, deer, porcupine, ravens and crows, paint and sticks, computers and cell phones and cameras and audiovisual technology, all embraced by a greater circle of Native and non-Native visitors. Relationship was central to our work. Participants were present and intentionally there for each other as individuals and as a community. This was evident as we all gathered as a family huddled into the red fabric tent that housed the opening show. This was also particularly evident in the community-based participatory embodied loom activity in the Community Engagement Center.

The embodied loom represented our ubiquitous intersections as humans. People from throughout the community came together to create not only a tapestry but also the machine that made the tapestry. We used our physical bodies to be the legs that supported the project and the arms that worked the fabric through the warp and weft. People became both the weaver and the loom as we constructed a tapestry collectively. During this process, the community was engaged in discussion about how textiles can be a gateway for understanding the interwoven nature of the “fabric of society.” Thoughts and personal experiences were written on fabric strips and woven into the finished piece. The woven tapestry was added to *INDIGENIST* for the month of November. This project invited us to weave together different strands of our ways of being, knowing and doing, to make a whole which demonstrated the importance of relationship and how much stronger we are together. As the Shawnee leader Tecumseh said, “A single twig breaks, but the bundle of twigs is strong.”

As the exhibition evolved, we noted how each piece plugged into the next and how common themes and patterns surfaced from all the artworks. We sat in a circle around our works, just days before the exhibition closed, and noted so many shared experiences of vulnerability, humility, pain, acceptance, kindness, respect, honor, strength, humor, and pride. Being a part of this exhibition created a reason for all of us to gather together, pray together and question, breathe, channel, answer and celebrate together, realizing that we have talent and sup-



Fig. 7. *Indigenested*

porting each other in sharing those gifts. Questions that might have remained individual led to shared laughter and tears and hugs, with recognition of our relatedness and a positive, communal questioning: *In what ways are we feminists? In what ways have we advocated for Native health and wellness? How does being an artist impact our lives? What else did we learn? Where do we go from here?* As one poet’s abstract testified, “I will move on and hope that my poem can relate to all of you viewers. . . . I hope that (this) can help you heal.”

Reconstruct

INDIGENIST served as an opportunity to construct stories that shared who we are, where we come from, what we have lived through, what we do, and why we do what we do. Through the arts, we were able to, both physically and metaphorically, root ourselves in what has been passed down to us (culture, craft, and community) to establish a nurturing space (with nests in a warm and yielding red house) where we could work together to untangle and intentionally weave fragments of our past, present, and future into a tapestry of problems and solutions. This is visible in *Woven Tapestry*. But it is also recognizable in the fallen and broken cottonwood twigs that were reconstructed into *Indigenested*, nurturing new life (Fig. 7). This was also particularly apparent in the speech *Stronger than Ever*, when the artist spoke about the way that Native American women from the seventh generation came together at Standing Rock to reclaim their voices and turn a threatening challenge into a reason to rebuild community and start to deconstruct colonization. *Insane thoughts of a sober mind—a variety of poetry readings* also spoke to the many stories

that are told about Native people or even stories that we tell ourselves and how these can be deconstructed and reconstructed.

We shared humble stories of identity that brought voice to many ways of being, knowing, and doing that are not often presented in the mainstream media. Indigenists are engaged in the arts to give voice to living traditions and cultures that demonstrate strength, suffering, and healing. Being asked to participate in *INDIGENIST* was an honor that inspired women to learn more and to share more. As we reconstructed our stories, we developed more acceptance and compassion for both ourselves and others. In our talking circle, one artist said, “the more I understand my ancestors, the more it’s okay to be me,” and many agreed.

As one poet’s abstract shared, “I use poetry to share my story, my history, my ancestry, my beliefs, my love, my mistakes, the way I see the world, my hopes and dreams”; in performance, she even referred to her poetry as “music” and said to the audience, “you get to hear the lyrics.” The arts speak to our identity, and through the arts we were able to share what it means to be who we are as artists, as advocates and as Native American women. This means that we were able to deconstruct the misleading stories that have previously and so pervasively been told about Native people and to tear down the walls infringing on our way of life and reconstruct our story with respect for Indigenous ways. This included showcasing the importance of learning how to make traditional and contemporary art, weaving the past into the present, and speaking the future into being. This was true for artists on a personal level as well as a societal level. *INDIGENIST* pulled knowledge forward and reconstructed what it means to be a Native American woman from a health advocacy perspective. Through tradition, symbolism, and innovation, we created traditional and contemporary art that connected to living traditions and cultures. We literally used scissors to cut old strands of cloth to add to a bundle that we carried in our basket to bring to the community to tie and work together to make a tapestry. *Woven Tapestry* is a symbolic outcome of the process of deconstructing and reconstructing our story.

Reflect

In creating the works of art, we engaged in reflection-in-action, and let that guide each next step. For example,

in the abstract, the creator of *Indigenested* described, “The first day, I was about to snatch sticks that had fallen from the cottonwood trees in our yard, when I remembered my manners. I returned with tobacco to offer, apologized, and sought permission to make nests.” The creative process involved pausing in reflection to offer a prayer, apologize, ask for permission, wait for what comes and express gratitude for what is given. Creating and curating art is a thoughtful and meditative practice. Participation in *INDIGENIST* called us to reflect and contemplate what it means to be who we are. Pausing in honor of Indigenous Peoples’ Day or Native Heritage Month was an act of contemplation. Witnessing performances and beholding works of art, noticing the symbolism in the patterns and details, was a practice of mindfulness. Both the act of storytelling and of story-listening were an art of reflection. Standing in awe, quietly, and listening to words and honoring silence was an art of observation.

Reflection was a part of the creative process, not only in curating the exhibition but also in creating the artworks and the abstracts that describe each piece. Artists described this project as a process of exploration and discovery. Reflection-on-action was evident in artists’ abstracts and in their notation of what the creative process was like, what their art represents, what they hope for, and what they want viewers to see, to feel, to know. The research process embodied this. Studying and analyzing art in this exhibit through research called for reflection on many different levels of meaning and purpose. Our data suggested that the *INDIGENIST* exhibition reflects healing, gratitude, and hope. The artworks self-organized to establish a sense of balance where the bad sat with the good. We experienced tears of suffering and joy. We shared and affirmed the delights and difficulties of the creative process. Ultimately, we found that the exhibit reflected us as quiet, proud, strong women, and the artworks exhibited an understated sense of sacredness.

Reciprocate

The creator of *Josephine and Her Six Daughters* explained in the abstract: “when I painted this piece, I felt the spirit and energy of my great-grandmother, Josephine, and her six daughters. These strong Native American women often visit me when I paint, and lend their gentle support, wisdom, and inspiration as the paintings take

shape.” Even our relatives, the cottonwoods, participated as “enthusiastic co-artists.” *Children of the Selu* notably evolved with help from ancestors and the Creator. In fact, the dolls’ hearts of rock were symbols of the strength that was passed down to the artist and shared within the exhibit. Another artist’s abstract referenced “the resilience of (her) relatives past and present” and the ways that she learned from her relatives which were enacted in the art that she presented. Others spoke to the resilience drawn from ancestors and how that can continue to be shared with relatives and students not only in everyday life but also through the arts.

As women artists and advocates, *INDIGENIST* artists expressed awareness of the gifts they inherited from their ancestors and the responsibility to share those gifts. Words like “marsí” (“thank you” in Michif) and “wado” (“thank you” in Cherokee) demonstrated our gratitude. The trees gave of their branches to make nests. The gardens gave of their corn and sweetgrass to make dolls. The animals gave of their hide to make moccasins and purses. In return, the artists gave of themselves to make art and share their stories. Being asked to contribute to *INDIGENIST* felt like being given a gift, what some described as the gift of feminist space. All artists expressed feeling responsible to share in return. We shared a balance of storytelling and story-listening, laughter and tears, applause and hugs. Aware of what one artist’s abstract described as the “responsibility that we carry with passing on these traditions,” we shared from our hearts what has been shared with us.

Rally

The *INDIGENIST* exhibition began with the people assembling in prayer. At the first show, the prayer was offered in private, and sage was burned and passed around among co-curators, smudging the people and the space to ask for good work, blessings, strength, and healing. At the second event, all visitors, co-curators, and artists formed a circle and an elder in our community offered a public blessing and passed sage around to each individual in the circle as a way of asking for purification, protection, and blessings. Each person present played their part in this ceremony and each person took on responsibilities; this was markedly obvious in the embodied loom activity. Moreover, each piece of art also played its role and plugged into its place in the room, on the walls, the stage, the easel, the music stand, and even

within the audience. Each piece grew stronger when placed next to the others.

One abstract mentioned the “internal battle” that inspired *INDIGENIST* works and others mentioned a number of other challenges that Native American people are regularly up against: racism, bullying, pain, and statistics. Beyond this, artists also mentioned the following gifts: hopes, dreams, strengths, recovery, sharing, helping, learning, and healing. In rallying, people come together and continue fighting to recover or cause to recover in health, spirits, or poise (Dictionary.com 2018). As the *INDIGENIST* presentation *Stronger than Ever*, explained, as a diverse group of Native American women from tribes all across America came together to protect their rights at Standing Rock, the meaning of the word “rally” came to life. That strength was transferred to the *INDIGENIST* audience and was palpable among the circle of women who listened in the gallery. When one poet read her work and told her story that ended in tears and another spoke to her road to recovery from addiction, they were embraced and empowered. A visit to this exhibition made it clear that the women involved in *INDIGENIST* rallied around each other and the community rallied around them.

The most common word used to describe *INDIGENIST* in our circle was “powerful.” Participation in this exhibition, both the individual art-making and the communal art-sharing was said to be valuable, nurturing, and overall healing. During a talking circle, one artist said, “it healed me” and another explained, “it affected me in a very good way, a way that few projects have.” There was a sense of solidarity in coming together around a cause that resonated with each and every one of us and the freedom to contribute in our own unique ways. The seven women in *Josephine and Her Six Daughters* formed a sense of community in joining with the seven women in *Children of the Selu*. *Imperfectly Perfect Moccasins* became more meaningful next to the work in *Continuing Tradition*. We all found strength in sharing the experience together.

Discussion

Métis leader Louis Riel said, “My people will sleep for one hundred years, but when they awake, it will be the artists who give them their spirit back” (July 4, 1885; Manitoba Métis Federation, qtd. in Episkew 2009, 192). *INDIGENIST* gave voice to artists who advocate for

health through individual art, poems, and performances as well as the overall creative process and community context. The art in *INDIGENIST* comes from a strong sense of place and speaks to cultural beliefs, values, and attitudes and shared knowledge. Together, our voices as artists-advocates-curators-researchers described seven components of Native American women's advocacy in health and wellness. The *Bundle of Seven Strands* represents a preliminary attempt to articulate the advocacy processes operating through Native American women living in urban areas in a colonized world.

The context of historic and contemporary oppression highlights the strength, resilience, and hope offered through Indigenous perspectives. The product of an Indigenist health advocacy theory can bridge existing knowledge of Indigenous theories with a substantive, theoretical framework that can be applied and utilized by any persons in any situations that call for advocacy for Indigenous peoples and places and the ways that we relate to them through knowing, being, and doing. A theoretical framework presenting an Indigenist understanding of health advocacy can facilitate more effective organization, planning, and evaluation of activities or interventions aiming to support health and wellness through Native American women and their advocacy efforts (Breurer et al. 2015).

Accessing knowledge through the arts is a unique research method. This study demonstrates how the arts can help us gain an understanding of how healing values and beliefs are expressed in practice. As artists and advocates, we met contemporary challenges related to health and wellness from within our own life stories, cultures, and communities. In doing so, we shared knowledge that can lift and support future generations. This art-based grounded-theory study can be acknowledged as an original endeavor in the field of Native American health and wellness. The findings have practical implications for informing health advocacy efforts and public health interventions that resonate with Indigenous ways of knowing, being, and doing. The implications of this research are both theoretical and practical. In fact, what we have shared "is a relationship with all creation. It is with the cosmos; it is with animals, with the plants, with the earth that we share this knowledge. It goes beyond the idea of individual knowledge to the concept of relational knowledge" (Wilson 2008). As Wilson explained, "Indigenous research is the ceremony of maintaining accountability to these relationships" (2008).

Historically, grounded-theory studies have been

considered "silently authored" and researchers have been considered "distant experts" (Mills, Bronner, and Francis 2006), but through this study we have demonstrated the importance of identifying researchers and using reflexivity to integrate researchers' voices and understandings into the research process and the final product. Indigenist advocacy was embodied not only in the roles of artists-advocates but also in the roles of curators and researchers. Together, we created social spaces where we were able to gather around rich data and develop a contextualized understanding of the human experience by considering many perspectives to reveal concepts and ideas that were not specific to any one particular participant. Relating the data to the people enabled us to mutually construct, deconstruct, and reconstruct meanings to ground stories into a theoretical framework. Although the qualitative nature of this study allows us to account for unique and general findings, out of respect for the diversity of Indigenous Peoples and Nations and their ways of knowing, being, and doing, we cannot extend our findings to wider populations with the same level of confidence that quantitative analyses with a larger population may be able to do.

While confirming much of the extant literature on Indigenous advocacy, this study offers new insights on the definition of "Indigenist" and makes distinct contributions to theories of advocacy by developing a grounded theory that illumines the advocacy process as informed by urban Native American women's ways of knowing, being, and doing. According to Walters and Simoni, "an indigenist perspective is a progressive, Native viewpoint that acknowledges the colonized . . . position of Natives in the United States and advocates for their empowerment and sovereignty" (2002, 520). This article presents an Indigenist perspective, from a circle of women who advocate for Native American health and wellness, cultural education, and public health research.

This study reaffirms Million's argument that Native American women, along with the spirit of their ancestors, have the "strength of knowledge and theory that has a capability to heal" individuals, families, communities, nations, and the earth (Million 2009). As Wilma Mankiller explained, "it is the women who are responsible for bringing along the next generation to carry the culture forward" (Mankiller 2009). Our great-great-grandmothers, our great-grandmothers, our grandmothers, our mothers, our sisters, our neighbors, and our friends brought this work to us, and in reciprocity we brought it to you. Indigenist perspectives, like

those shared in this article, will support not only Native American community members but also public health researchers and practitioners in promoting health and well-being for Indigenous women and their communities (Walters and Simoni 2002). We hope that in some way this work shakes the spirit and that the arts awaken more advocacy in support of Native American health and wellness.

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Compliance with Ethical Standards

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Ethical approval

This article does not contain any studies with human participants or animals. Researchers analyzed visual, written, and verbal data which were shared publicly in an art exhibition, *INDIGENIST*. All presenting artists and co-curators involved in *INDIGENIST* are authors on this manuscript. This study was reviewed by the Institutional Review Board at the University of Nebraska Medical Center, which determined the study to be exempt, as it did not constitute human subject research.

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Using Closed-Captures Population Analyses to Estimate Channel Catfish Relative Abundance

Cameron W. Goble, Camden Oathout, and Mark A. Pegg

ABSTRACT—Channel catfish (*Ictalurus punctatus*) is an important recreational species in the Great Plains, and understanding the reliability of population data is critical to proper management. We therefore compared estimates of the abundance of channel catfish > 200 mm within a 6.2 river kilometer (RKM) reach of the Missouri River, Nebraska, using estimates derived from the Schnabel batch-marking methodology, closed-captures analyses using capture histories of uniquely marked individuals, and a method for extrapolating relative abundance (C/f) to absolute abundance using mean capture probabilities. Estimated abundance of channel catfish derived using the Schnabel method was 23,949 fish (18,011–39,120; 95% confidence interval). Closed-captures analyses yielded an estimated abundance of 25,817 channel catfish (24,885–26,785; 95% confidence interval). The estimated abundance of channel catfish extrapolated from C/f was 26,121 (24,755–28,056; 95% confidence interval). The smaller confidence intervals around estimates derived using uniquely marked individuals suggest the closed-captures method may result in more robust estimates than those derived using batch-marking techniques or C/f . However, all three methods produced similar estimates of channel catfish abundance. Our results confirm the hypothesis that C/f is proportional to abundance in this study, suggesting an index of relative abundance may be useful when sampling resources are limited.

Key Words: abundance, channel catfish, Missouri River

Introduction

Channel catfish (*Ictalurus punctatus*) is one of the most important freshwater recreational species in the United States (Vokoun and Rabeni 1999) and this is especially true in the Great Plains (Hubert 1999; Barada and Pegg 2011; Blank et al. 2017). Specifically, Michaletz and Dillard (1999) found that catfish (e.g., channel catfish, flathead catfish [*Pylodictis olivaris*], blue catfish *Ictalurus furcatus*, and “other” catfish species) were deemed important to anglers by fisheries managers from 32 management agencies across the USA. Similarly, a United States Department of Interior survey (2018) estimated there were 8.1 million catfish anglers in the USA in 2016. Given their prominence in the recreational fishing community, it is important that resource managers have accurate information on channel catfish populations to ensure proper management actions. One of the most critical information needs is having accurate abundance estimates.

Estimates of population characteristics such as relative abundance, size structure, and mortality are metrics commonly used by fisheries resource managers to assess fish populations. Absolute abundance (population size) is less frequently assessed, as robust calculations of abundance require more time and resources than are typically available when attempting to manage multiple systems (Hubert and Fabrizio 2007). Consequently, fisheries resource managers must make decisions regarding population sustainability using relative abundance information, typically without knowing how this index performs compared to absolute abundance.

Measures of relative abundance are most frequently expressed in terms of catch per unit effort (C/f) where C is the number of fish caught and f is a standardized unit of effort (Fabrizio and Richards 1996; Hubert and Fabrizio 2007; Hubert et al. 2012). Relative abundance is assumed to be related to absolute abundance (N) by means of a coefficient of catchability (q), resulting in the general C/f equation:

$$C/f = qN.$$

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Numerous studies have demonstrated that q is often sensitive to changes in fish distributions (Paloheimo and Dickie 1964 in Hubert and Fabrizio 2007), fish density (Ricker 1975; Hilborn and Walters 1992 in Hubert and Fabrizio 2007), and environmental factors (Hubert and Fabrizio 2007). Thus, measures of C/f may not be truly reflective of differences in abundance as much as they are reflective of differences related to other factors such as distributions, density, and environmental factors in some ecosystems.

Basic population estimation methods such as the Schnabel method use a batch-marking approach where the recapture of specific individuals is not a factor in the model (Hayes et al. 2007). Rather, the proportion of marked individuals versus unmarked individuals during each sampling occasion is used to estimate the total population size. Important parameters such as capture probability and recapture probability are not estimable with the Schnabel method. More advanced population estimation techniques such as closed-captures capture-mark-recapture modeling, open-population capture-mark-recapture modeling, and so on, have been developed to address some of the issues associated with estimating animal abundance (Barker and White 2004). These more advanced techniques use encounter histories of uniquely marked individuals to estimate not only abundance and density but also population parameters such as capture probability, survival or mortality, and movement.

Hurley and Duppong-Hurley (2007) reported that the Missouri River had the highest use of any Nebraska river by catfish-seeking anglers, suggesting that Missouri River catfish populations are important resources to the people of Nebraska and likely the surrounding states. Managing fish populations in waters with multiple geopolitical jurisdictions can be complex if harvest regulations vary among resource management entities. For example, catfish management in the upper channelized portion of the Missouri River falls under the jurisdiction of five states (Iowa, Kansas, Missouri, Nebraska, and South Dakota). All five states banned commercial catfish harvest from the Missouri River in 1992 due to concerns about declines in catfish stocks (Mestl 1999). However, recreational harvest of catfish does still occur and creel limits vary. Current (2019) regulations in Kansas, Missouri, and Nebraska allow anglers to harvest five channel catfish and five flathead catfish per day, South Dakota allows anglers to harvest 10 catfish of any species per day, and Iowa allows anglers to harvest

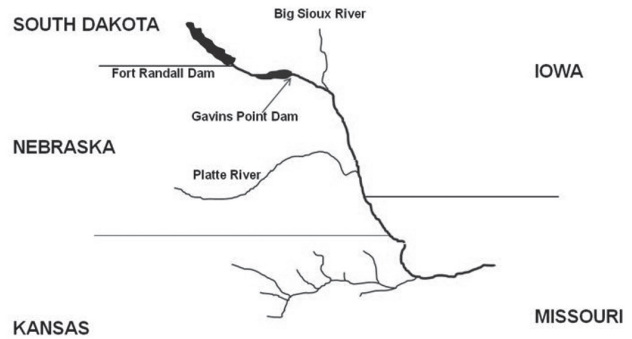


Fig. 1. Diagram of the Missouri River, Nebraska, showing the approximate location (star) of the study bend (RKM 1,122.8–RKM 1,116.6) sampled for closed population estimation in 2010.

15 catfish (channel catfish or flathead catfish) per day. These varying management strategies make it important to monitor and evaluate key characteristics of the catfish populations in the Missouri River to ensure proper management. The current monitoring regime relies on C/f data to assess the status of catfish populations, but there is a need to understand how relative abundance data are related to absolute abundances. Therefore, the objective of our study was to evaluate how well relative abundance estimates track absolute abundance for channel catfish within a reach of the Missouri River. This objective also facilitated a means to assess changes in previous channel catfish population studies from the Missouri River.

Methods

Field Sampling

We sampled one 6.2 km reach of the Missouri River (from river kilometer [RKM] 1,122.8 to RKM 1,116.6) near Decatur, Nebraska (Fig. 1), from October 18 to October 22, 2010.

Sampling was conducted within 4 days in an attempt to comply with the assumption of population closure. We used small hoop nets, 0.6 m in diameter, with 7 hoops per net, of 25 mm mesh, following protocols detailed by Porter and Mestl (2009). A total of 20 small hoop nets were set on the inside bend in areas with depths greater than 0.6 m and sufficient water velocity to keep the nets from collapsing each day of sampling. Set sites were spaced to ensure there was at least one full wing-dam field (Fig. 2) between each net. All nets were baited with approximately 1 kg of cheese trimmings,

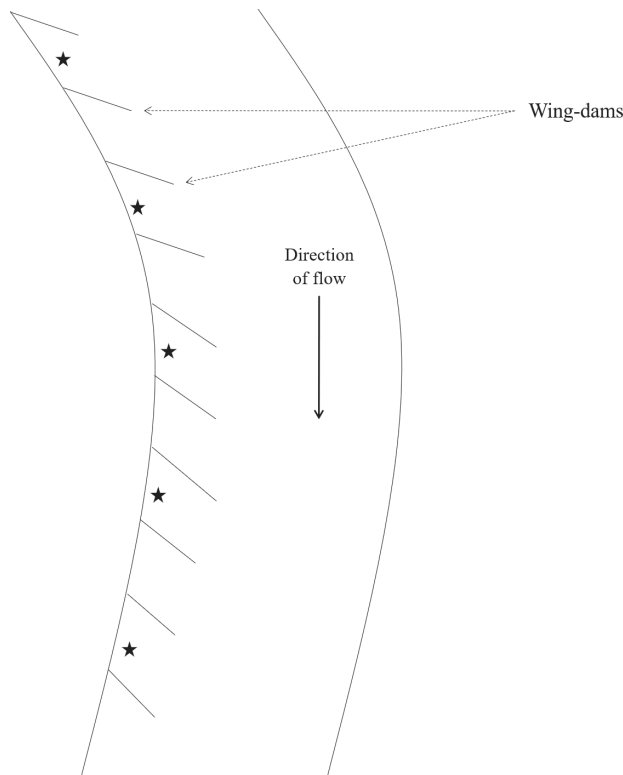


Fig. 2. Depiction of hoop-net spacing on a study bend. Stars represent hoop-net set locations.

weighted with a concrete block, and anchored to shore with a hoop-net hook. Nets were fished overnight with a total set time not exceeding 24 hours, and reset immediately following retrieval for a total of four consecutive net nights at each set site.

All channel catfish collected were measured for total length (mm) and mass (g). Channel catfish greater than 200 mm were marked by clipping the adipose fin and implanting a FD-94 T-bar anchor tag, stamped with a unique identification number, between the dorsal pterygiophores on the left side of the fish. All fish were returned to the water immediately at their location of capture (e.g., shoreline of inside bend) following processing and were assumed to be available for future recapture(s).

Data Analyses

We calculated the population size of channel catfish >200 mm within the 6.2 RKM study bend using two methods. First, we used the Schnabel method (Schnabel 1938; Seber 1982; Hayes et al. 2007) to calculate a

baseline population estimate. The general form of the Schnabel estimator is:

$$\hat{N} = \frac{\sum_i^t n_i M_i}{\sum_i^t m_i + 1}$$

Equation 1. Number of Channel Catfish

where \hat{N} = the estimated population size, t = the number of sampling occasions, n_i = the number of fish caught in i th sample, m_i = the number of fish with marks caught in the i th sample, and M_i = the number of marked fish present in the population for the i th sample (Hayes et al. 2007). We calculated 95% confidence intervals around \hat{N} as recommended in Hayes et al. (2007) using values provided by Chapman (1948).

We also created capture histories for each channel catfish >200 mm collected for closed-captures population estimation using Program MARK (White and Burnham 1999). Each sampling occasion (set-date) was included as a binomial response for an individual's capture history. We assessed three model formats: M_0 = constant capture probability (p) and recapture probability (c), M_t = time varying p and c (constrained so $p = c$), M_b = variability in c due to changes in behavior after capture (Otis et al. 1978; Hayes et al. 2007). All models were run using a LOG link function and Hessian variance estimation. Program MARK uses maximum likelihood methods to iteratively fit models to the data and selects the best fit model using Akaike's Information Criterion (AIC), where the model with the lowest AIC value is deemed to be the "best" model (White and Burnham 1999).

We calculated the mean relative abundance (C/f) of channel catfish >200 mm within the study bend using a generalized linear mixed modeling (GLMM) approach (Littell et al. 2006; Dobson and Barnett 2008). Biological data are often characterized by a high occurrence of zero counts, particularly when study organisms have low densities or patchy distributions (Hubert and Fabrizio 2007). These data cannot be assumed to have a normal distribution in these instances, as is required for standard parametric analyses. Generalized linear modeling (GLM) allows the data to be analyzed under different probability distributions such as a Poisson distribution or a negative binomial distribution. Addition of a random variable extends the GLM model to the GLMM format. The random variable is assumed to represent an

interchangeable sample from a larger population with a probability distribution, which allows for broad inference of overall population parameters (Littell et al. 2006). Both GLM and GLMM use transformations (link functions) of the model parameters ($X\beta$) based on the probability distribution of the data to fit a linear model on which statistical testing can be conducted. Inclusion of an inverse link statement in the model back transforms the generalized-scale parameter estimates to the original scale (Littell et al. 2006). We used net-set (net-1–net-20) nested within set date {Subsample (Set Date)} as the random variable in the GLMM which allowed the overall mean C/f of channel catfish >200 mm within the study area to be calculated.

To calculate absolute abundance from measures of relative abundance, we used a two-step process (equations 2 and 3) requiring both the C/f data derived from GLMM and capture probabilities derived from Program MARK. First, we divided the mean C/f of channel catfish >200 mm within the study bend by the mean capture probability (p) derived from the M_t model structure to calculate the mean number of fish available for capture at each net-set site during each sampling period. We then multiplied the mean number of fish available for capture at each net-set site by the number of net-sets for each day to get daily values of the total number of fish available for capture within the study bend during each sampling period (equation 2).

$$Ni = \frac{\mu C/f}{\mu p} * Si$$

Equation 2.

where Ni = the estimated number of fish available for capture within the study bend during sampling period i , $\mu C/f$ = the mean relative abundance of channel catfish within the study bend, μp = the mean capture probability derived from the M_t model structure using Program MARK, and Si = the number of net sets in sampling period i . Secondly, we calculated the mean of Ni (equation 2) to determine the bend-level mean abundance of channel catfish >200 mm within the study bend using equation 3.

$$\mu \hat{N} = \frac{\sum_i^t Ni}{t}$$

Equation 3.

Table 1. Channel catfish capture, recapture, and total number marked collected through spatially replicated hoop net sampling within a 6.2 river kilometer study bend along the Missouri River near Decatur, Nebraska, in 2010.

Set date	Total number of channel catfish >200 mm	Number of recaptures	Number marked
October 18	155	0	155
October 19	405	7	398
October 20	526	14	512
October 21	410	8	0

where $\mu \hat{N}$ = the bend-level mean abundance, t = the number of sampling periods. We calculated 95% confidence intervals around the estimate of $\mu \hat{N}$ by replacing μp with mean 95% confidence interval values of p derived using Program MARK. The lower 95% confidence interval of p was used to calculate the upper 95% confidence interval of $\mu \hat{N}$ and the upper 95% confidence interval of p was used to calculate the lower 95% confidence interval of $\mu \hat{N}$ following Powell and Gale (2015).

Results

A total of 1,704 channel catfish were collected in 75 small-hoop-net deployments between October 18, 2010, and October 22, 2010. Five of the nets were omitted from analyses because they either collapsed or suffered an issue that interfered with proper sampling deployment. About 88% ($n = 1,496$ including recaptures) of the channel catfish we captured were >200 mm and of those fish, 71% ($n = 1,065$) were marked with uniquely numbered t-bar anchor tags. We recaptured 29 channel catfish that had been marked between October 18, 2010, and October 22, 2010.

A total of 1,496 channel catfish were included in the Schnabel estimate of absolute abundance (Table 1). The estimated \hat{N} of channel catfish >200 mm within the 6.2 RKM reach was 23,949 fish (18,011–39,120; 95% confidence interval). Assuming channel catfish are equally distributed throughout the study bend, this equates to an estimate of 3,863 (2,905–6,310; 95% confidence interval) channel catfish >200 mm per RKM within the study bend.

Table 2. Channel catfish encounter histories used for closed-captures analyses within a 6.2 river kilometer study bend along the Missouri River near Decatur, Nebraska, in 2010.

Encounter history	Number of fish
1000	140
1100	7
1001	1
1011	1
1010	7
0100	388
0110	8
0101	2
0010	508
0011	4
0001	404

Note: The single fish represented in the 1011 encounter history is also included in the 1010 encounter history.

A total of 1,470 distinct channel catfish were used in the closed-captures analyses of absolute abundance using Program MARK. Included in the capture histories of those individuals were 26 individuals with one or more recapture events. Eleven unique encounter histories were observed (Table 2).

The M_t model had the lowest AIC (Table 3) value and thus the best fit.

The estimated \hat{N} of channel catfish >200 mm within the 6.2 RKM reach was 25,817 fish (24,885–26,785; 95% confidence interval). Assuming channel catfish are equally distributed throughout the study bend, this equates to an estimate of 4,164 (4,014–4,320; 95% confidence interval) channel catfish >200 mm per RKM within the study bend. Capture and recapture probabilities (constrained to be equal) under the M_t model structure ranged from 0.6% to 2.0% (Table 4) with a mean of 1.5%.

Kolmogorov-Smirnov tests for normality confirmed the data were not normally distributed ($p < 0.01$) where models using a negative binomial probability distribution provided a better fit ($\chi^2/\text{degrees of freedom} = 1$). Mean C/f of channel catfish >200 mm within the 6.2 RKM study bend was 20.2 (14.7–27.8; 95% confidence interval) fish per net night.

Bend-level mean abundance ($\mu\hat{N}$) of channel catfish >200 mm calculated using equations 2 and 3 was 26,121

Table 3. Akaike's Information Criterion (AIC) values comparing competing closed-captures model structures.

Model	AIC	Δ AIC
M_t	-14,317.88	0.00
M_b	-14,107.31	210.56
M_o	-14,095.50	222.38

Note: M_t = time varying capture probability and recapture probability, M_b = variability in recapture probability due to changes in behavior after capture, M_o = constant capture probability and recapture probability.

Table 4. Capture and recapture probabilities derived from closed-captures analyses and mean (μ) capture probabilities used for calculation of bend-level mean abundance of channel catfish within a 6.2 river kilometer study bend along the Missouri River near Decatur, Nebraska, in 2010.

Sampling period	Lower 95% confidence interval	Capture and recapture probability	Upper 95% confidence interval
1	0.006	0.006	0.006
2	0.014	0.016	0.017
3	0.019	0.020	0.021
4	0.015	0.016	0.017
μ	0.014	0.015	0.015

(24,755–28,056; 95% confidence interval) fish within the 6.2 RKM reach. Assuming channel catfish are equally distributed throughout the study bend, this equates to an estimate of 4,213 (3,992–4,525; 95% confidence intervals) channel catfish >200 mm per RKM within the study area.

Discussion

A fundamental assumption of both the Schnabel method and the closed-captures analyses is that the population being assessed is closed to immigration, emigration, births, and mortalities during the study period (Darroch 1958; Seber 1965; Kendall 1999; Hayes et al. 2007). Violation of this assumption can introduce bias for estimates of the population parameters, and Otis et al. (1978) point out the assumption of a closed population is likely difficult or impossible to completely attain. However, proper study design can approximate a closed-captures design (Otis et al. 1978). We attempted

to minimize any bias associated with violations of the closure assumption by conducting all sampling within a relatively short time period (4 days) and using the same collection method. We used hoop nets specifically because they provide good catch rates and provide the most accurate representation of the population at this time of year (Bodine et al. 2013). Using additional collection techniques (e.g., electrofishing, angling, etc.) may have increased sample sizes and possibly recapture events, but would have introduced additional bias associated with these gears that could have confounded the closed population aspect of this study. Therefore, we have generally put all abundance estimates in a similar context that allows us to make valid comparisons among the three population estimation approaches.

Analytical comparisons of abundance estimators or relative abundance estimate techniques are ubiquitous in both the marine (e.g., Harley et al. 2001) and freshwater (e.g., Rosenberger and Dunham 2005; Campbell et al. 2015) fish literature, but rarely have such studies validated relative abundance as being proportional to abundance. This is especially true in large rivers. Our data indicate the Schnabel and closed-captures analyses yielded population estimates of approximately 24,000–26,000 channel catfish >200 mm within the 6.2 RKM study reach. The population estimate derived using the closed-captures approach ($25,817 \pm 932$) had much tighter confidence intervals around the estimate of \hat{N} than the estimate derived using the Schnabel formula. Closed-captures analyses also provide valuable information on capture and recapture probabilities that are not possible to estimate using the Schnabel method. However, in situations when uniquely marking all individuals is not feasible, it appears that the Schnabel method can provide estimates of \hat{N} similar to those derived from the more complex model, although the error associated with the estimate will likely be much larger. Furthermore, our extrapolation of the channel catfish population using C/f appears consistent with the more data intensive population estimators. Additional assessment of using C/f as a proxy for true abundance is needed, but we have provided an initial validation that hoop nets do approximate similar population sizes relative to the Schnabel and closed-captures approaches for channel catfish in the channelized Missouri River. This validation will provide resource managers the confidence to know that their index of abundance is truly representing the population.

Comparing our results to previous work on the Missouri River suggests changes in channel catfish population size has occurred. Newcomb (1989) used Program CAPTURE (White et al. 1978) to estimate the density of channel catfish ≥ 250 mm at locations near our sites in the Missouri River and estimated densities ranged from 776 to 976 fish per RKM. Density estimates from our study, while not directly comparable due to differences in minimum tagging length (200 mm in the current study vs. 250 mm) suggest that channel catfish density in the upper channelized portion of the Missouri River may have increased since Newcomb's (1989) study. A possible explanation for increased channel catfish density is the closure of the Missouri River commercial catfish fishery in 1992. Channel catfish mortality rates have declined in the Missouri River from about 72% in 1974–1990, to about 35% in 1994–1998 (Mestl 1999). Theoretically, reducing annual mortality should increase the number of individuals within a population, leading to greater density and indeed that has happened in other channel catfish populations in the Great Plains (Siddons et al. 2016).

Perhaps the most intriguing finding of this study was that our three approaches to estimate abundance of channel catfish in the Missouri River produced similar results. Estimates of C/f are commonly used by fisheries resource managers to assess fish populations as these measures are relatively easy to calculate and the costs to gather C/f data are typically less than those necessary for capture-mark-recapture sampling. Absolute abundance (population size) is less frequently assessed because robust calculations of abundance require more time and resources than are typically available when attempting to manage multiple systems. However, Rosenberger and Dunham (2005) showed relative abundance of rainbow trout (*Oncorhynchus mykiss*) from electrofishing catch data was correlated with abundance estimates. Similarly, Hopkins and Kennedy (2004) found strong correlation between small mammal C/f and estimates of absolute abundance. Our results support the notion of C/f being proportional to absolute abundance in our study, but further research and validation will be needed to determine if our technique can be used on a larger scale and applied to other systems. Ultimately, true population estimates, or validated indices of them, will allow better insights into the status of fish populations and provide more confident insight when making resource management decisions.

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Where Are the Native Americans?

Early Priorities of the South Dakota State Medical Association

Carolyn Ly-Donovan, Reed Ritterbusch, Evan Meyer, and Daniel Schmidtman

ABSTRACT—Our study examines the relationship between the South Dakota State Medical Association (SDSMA) and members of a historically marginalized group in the state. Through archival research and cultural analysis, we identify priorities of the South Dakota State Medical Association early on in its organizational development, and during key moments for Native American healthcare, reconstructing the relationship between the Association and this population in the early 20th century. Primary documents were derived from the SDSMA Collection housed at the Center for Western Studies (Sioux Falls, SD). By examining the SDSMA's priorities in comparison to federal level changes occurring with Native American healthcare, we identified time periods of interest, in particular, during 1882 to 1956. This period includes the institutionalization of Indian Health Services (IHS), a critical moment when one might expect the SDSMA to discuss issues relevant to healthcare in the state and the prevalent Native American people therein. References to Native American populations were of interest by either their lack of inclusion or through the particular nature of their presence in the archival material. We demonstrate that while the SDSMA showed strong involvement in legislation affecting the practice of allopathic medicine in South Dakota, no mention of any major Native American health initiatives was seen, even during the formation of the IHS. Our findings provide insight into the role of seemingly neutral organizational structures, such as professional associations, as they contribute to the persistence of systemic inequality.

Key Words: AIAN, American Indians, healthcare, Indian Health Service, medical associations, Native Americans, South Dakota

Introduction

As a voluntary professional organization, the South Dakota State Medical Association (SDSMA) may seem to have little explicit connection to contemporary issues in Native American healthcare needs and inequities. Yet we contend that by examining the Association's archival documents, the Association's role and connection to the establishment of inequities early on for Native American peoples in the state of South Dakota becomes apparent. Our study establishes that, even during the beginning stages of the organization in the early 20th century, members built and garnered their power to influence healthcare policy statewide. In contrast, simultaneously, while the institutional recognition of Native American healthcare as part of the trust responsibility of the United States government was being established in 1921, the SDSMA physicians paid

little to no attention to these relevant occurrences despite prevalent populations of such peoples in their state. Through archival research and cultural analysis of the Association's official documents, we identify key moments within organizational history, with a particular focus on reconstructing the relationship between Native American populations and the organizational priorities of the South Dakota State Medical Association in the early 20th century.

The Great Plains has long been an important region of Native American peoples, with the Dakotas being at the heart of the region. At the end of the 20th century, South Dakota was ranked third for percentage of the population being "American Indian/Alaskan Native" (AIAN) (US Census 2000), making South Dakota a prime region for studying the historical relationship between Native American peoples and emerging medical professions in the 19th and 20th centuries. Our study stretches from 1882 (the year of the first meeting to establish a medical association for the Dakota territory) to 1956, encompassing a period of significant change to national Native American healthcare. While the ar-

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chived collection contained additional years of the organizational history, this timeframe gave ample insight into how the Association's development coincided with the creation of AIAN healthcare policies and the Native American populations in South Dakota.

By critically analyzing the SDSMA archival data, we identify issues that have existed since the earliest stages of institutionalization, pointing to how contemporary problems may be inextricable from these early organizational processes. Thus, our analysis highlights how contemporary issues in Native American health are linked to longstanding exclusion from healthcare initiatives, reinforcing a systemic legacy of problems embedded in the formation of organizational healthcare structures. This understanding illuminates the shortcomings of current discussions, which focus solely on questions related to "bad" policies or "poor" management. Policy decisions and issues of efficiency are pertinent in the management of large healthcare systems; however, we argue that while current actions within healthcare may exacerbate an already problematic system, focusing on these relatively anachronistic events as the source of today's inequities obfuscates more complex dynamics that occur. Consequently, we must first acknowledge that the problems inherited by the existing system (i.e., IHS) burgeon from roots that preexist any conditions of the current institution and were problematic from its inception. Our research empirically explores the roots of contemporary issues by examining whether, or to what degree, professional medical doctors within the Association recognized Native Americans in South Dakota as an important group, and more specifically, whether Native Americans were referenced or included in decisions about health agendas and policies during the nascent stages of institutionalized healthcare.

We find that Native Americans are largely absent from the conversation among SDSMA members and the institutionalizing agenda of the group. In this article, we present and discuss the primary organizational initiatives that the SDSMA pursued early on in their organizational tenure, in conjunction with an analysis of the ongoing institutional shifts within Native American healthcare and the related federal-level structures. First, we establish that (despite being a voluntary association) this group of professionals possessed power in shaping healthcare-related policies and regulations at the state level during crucial periods of institutionalization. Next, we identify and illustrate which particular groups of people were made important or considered relevant

when targeting health outcomes for those living in the state. Within this context, we discuss the consequences of a group being left absent from association proceedings. Furthermore, in our analysis, we explain the relationship of these decisions in the context of shifting institutional approaches to dealing with AIAN by the federal government in terms of health-related policies. Throughout the article, we primarily use the term "Native American"; however, when referring to federal healthcare policies or in direct reference to such legislation, we use the abbreviation AIAN, as well as "American Indian" or "Native American (Indian)" and "Alaska Native" to reflect AIAN federal-level policy language.

By exploring how issues of structural inequality are embedded within the process of organizational development, we illustrate how the Association's activities contributed to the systemic exclusion of Native Americans during critical moments in AIAN healthcare policy creation, implementation, and change. Analysis of SDSMA archival data facilitates the ability to scrutinize meanings and practices that were made significant over time by medical professionals in the state of South Dakota. Moreover, the presence or absence of particular groups explains the relative significance and attention accorded to each group. Thus, this article also highlights the value of historical-cultural methodology and analysis that critically engages with archival material. This approach has the potential to provide insight into the role of seemingly neutral organizational structures as they contribute to the persistence of systemic inequality, with particular attention to marginalized groups, which in our case, focuses on Native Americans.

American Indian/Alaska Natives Health Services

The United States entered into many agreements that included promises of "proper care and protection" in exchange for tribal land and natural resources (Warne and Frizzell 2014, 263–67). These promises manifested as social contracts wherein rights and services guaranteed to the AIAN people were identified in various treaties, executive orders, and other legal bindings, most of which were established between 1778 and 1868. These formal commitments placed a legal obligation on the United States government to provide health services to AIAN tribes, establishing a framework for explicit responsibility to provide care for Native Americans. However, the

current state of Native American health exemplifies the stark disparities in the access to healthcare and quality of care provided to this community, which is also reflected in their subsequently poor health outcomes.

The 573 federally recognized AIAN tribes (USCCR 2018, 12) are connected with the United States via a complex web of federal Indian policy, intergovernmental relationships, and 375 treaties (USCCR 2018, 1). The Indian Health Service (IHS) is responsible for the provision of full health coverage to eligible Native Americans, currently identified by IHS on their “Disparities” and “IHS Profile” fact sheets as approximately 2.2 million of the nation’s estimated 3.7 million AIAN people (IHS 2018a; 2018b). The Indian Health Care System delivers care through tribal-operated healthcare services, IHS-operated direct care services, and Urban Indian Health (UIH) services and resource centers (Singer 2009). Tribes manage over half of the funds appropriated to the IHS (USCCR 2018, 65). IHS direct and tribal services provide healthcare on and near reservations, operating under multiple funding structures from the US government. These are officially “set” budgets for IHS, yet in practice the required monetary support may fluctuate with funding cycles that are often tied to state and federal legislation, and political agendas often aimed at balancing the US operating budget deficit on an annual basis. Consequently, underfunding or delayed funding is a chronic concern and reality for IHS (USCCR 2018, 66). Urban Indian Organizations (UIO) are the 34 non-profit off-reservation facilities (USCCR 2018, 64) that provide UIH services to the 70% of Native Americans living in urban areas (USCCR 2018, 73). Limited by the few locations in which IHS facilities are located, many Native Americans have no access to IHS facilities due to geographical distance. If services are not available through IHS direct or tribal services, the IHS can purchase healthcare services through its Contract Health Services (CHS) program. Native American healthcare may come from alternate resources as well, such as private insurance, or through health insurance exchanges or expanded Medicaid eligibility that occurred with the Patient Protection and Affordable Care Act of 2010 (USCCR 2018, 89).

Beyond issues of facility prevalence, other structural barriers exist, creating disparities in healthcare as the result of organization decisions, physical limitations, and physician shortages. One particular issue is the inconsistency in availability of health services. In addition to clinical services, IHS pays for preventive medicine ef-

forts, facilities, personnel, mental health care, substance abuse programs, and contract support costs. However, these services are often criticized as being inadequately available, and it has been documented that limited funding—or gaps in predictable funding—leads to rationing of services, despite efforts from the IHS to meet healthcare needs. The financial appropriation, purchase, and reimbursement dynamics, along with other complex structural issues related to health services for AIAN peoples, are beyond the scope of this article and are more elaborately discussed in “Broken Promises: Continuing Federal Funding Shortfall for Native Americans” (USCCR 2018, 61–94).

Disparities in Health Outcomes

Native Americans, AIAN, now have “a life expectancy that is 5.5 years less than the US all races population (73.0 years to 78.5 years, respectively),” according to an IHS fact sheet on health disparities (IHS 2018a). Life expectancy and morbidity rates are linked to the ability to obtain proper and timely healthcare. Those with insurance often have little or no choice in where they seek care, and navigating between on-reservation IHS, off-reservation UIH, and CHS providers is a complicated and confusing process for those attempting to access resources within the healthcare infrastructure. And like other minority groups, Native Americans are less likely to have a family physician, reducing regular preventative visits (Singer 2009). Native Americans endure long waits before seeing a doctor and are unable to get referrals to see specialists, or have non-emergency care denied (Singer 2009). Compared to whites, AIAN are 770% more likely to die from alcoholism, 650% more likely to die from tuberculosis, 420% more likely to die from diabetes, and, like other minorities, are more prone to exposure to environmental risks (Singer 2009). Moreover, while infant mortality declined for all major racial and ethnic groups between 2005 and 2014, AIAN rates did not (Matthews and Driscoll 2017, 5).

Healthcare disparities for Native Americans are pervasive on a host of measures (IHS 2018b; USCCR 2018, 65), including particular disease outcomes such as higher cancer mortality rates (Clegg et al. 2002; Li, Malone, and Daling 2003; Ward et al. 2004; Guadagnolo et al. 2009), which have also been documented specific to South Dakota (Rogers and Petereit 2005; Petereit et al. 2008). Researchers have pointed to a variety of pos-

sible causes for such a noticeable difference in health outcomes for Native Americans, including issues such as medical mistrust, lower rates of preventative screenings, and presenting at advanced stages at the point of diagnosis (Guadagnolo et al. 2009). The inequalities in healthcare outcomes for Native Americans have roots in historical trends and practices affecting attitudes toward Native American health. Although federal US treaties, legal doctrines, and social norms suggest that there is an obligation dating to the 18th century to provide healthcare for Native Americans, they have yet to receive adequate health services from the federal government. To what extent can these contemporary issues be attributed to the systemic exclusion of Native American interests in the creation of healthcare structures? This is a complicated and multifaceted question that will take further examination to fully answer. However, we argue that our empirical work with the SDSMA archival data facilitates a critical perspective, one that points to the value of involving, or at the least acknowledging, Native American people and their experiences, needs, and interests, within the continued improvement of healthcare systems.

Methods

Primary documents were derived from the South Dakota State Medical Association (SDSMA) Collection housed at the Center for Western Studies located at Augustana University in Sioux Falls, South Dakota. The folders within this collection contain formal organizational materials such as annual meeting minutes and proceedings; council meeting transactions; presidential biographies; member ledgers and directories; and other informal organizational documents created, acquired, or retained by the SDSMA such as photographs, scrapbooks, event memorabilia, correspondences, and informational brochures related to healthcare. Principally used secondary documents include *A New South Dakota History* (Thompson 2009), the IHS website, reports, and published materials, the South Dakota UIH website, and select issues from the *South Dakota Journal of Medicine and Pharmacy* found online (1949; 1951). Archival documents noted as representing the organizational history provided a broad understanding of the SDSMA's priorities and reflected attention to aspects typical to organizational practices and initiatives that are part of growing any voluntary professional association. Building on this

broad overview, we sought to map key events and local state-level actions by the association, including what the members paid attention to and how they focused on growing and developing the SDSMA. Specifically, we looked for themes related to the Association members' primary concerns, internal debates on agenda, or discussion of potential or existing legislation, health-related events, actions, or outreach initiatives in the association's official organizational documents. For further details on early phases of data collection, please see the Methods Appendix.

In conjunction with reconstructing key events and initiatives at the local level, we examined the aforementioned secondary sources to map national legislative policy changes to AIAN healthcare, allowing us to compare and contrast the Association's interests and actions with changing policies. Based on this phase of archival work, we were then able to identify time periods of interest, in which one might expect the SDSMA to discuss issues relevant to healthcare in the state and the Native American people therein. More specifically, references to Native American populations were of particular interest by either their lack of inclusion or through the particular nature of their presence in the archival material. Major policy changes and periods during, before, and after such changes became targeted years for archival analysis. Specific materials from the SDSMA Collection most closely examined for this phase of research include 433 pages of handwritten or published materials by the association, including the Articles of Incorporation of 1883 and 1891; Minutes 1904–1914; Annual Meeting (“Session”) Proceedings 1915–1919, 1930; Official Proceedings 1920–1925, 1927; Miscellaneous Reports (Proceedings of the House of Delegates) 1926; Fifty-First Annual Session (Record of Proceedings) 1928; *Journal Lancet* 1925, 1933, 1945, and 1947; *This Is Your Medical Association* monthly newsletter, excluding July, from December 1946 to December 1947; and the 1954–1956 transactions.

Once the key periods were identified, we conducted thematic analysis of archival data from these periods by looking for information pertaining to the Association's priorities beyond membership, such as health initiatives, targeted health populations, and policies. Additionally, given our emphasis on exploring the representation of Native Americans in any form, we read all documents and took note of any mention of “Native Americans”; “Indians”; health services for non-whites; tribal healthcare; references to tribes, tribal land, reservations, or

any regional areas possibly associated with reservations; and the identification of a doctor or patient explicitly as Native or *interpreted* as Native based on their name (this was most relevant in reviewing membership rolls or records of deaths included in the Association's formal documents). Materials within the archives were cross-referenced when possible. Nonarchival data include corresponding information on policy changes or institutional shifts such as reference materials from the United States government on AIAN (US Census 1910; 2000); information from organizations dealing specifically with Native American healthcare needs such as IHS website or South Dakota Urban Indian Health website; and academic publications specific to the state of South Dakota, as previously mentioned.

Results

Where Are the Native Americans?

Our findings reveal that Native Americans were largely ignored or only tangentially addressed in discussions and actions targeting the health, safety, and well-being of the population in South Dakota. Significantly, when Native Americans were acknowledged, they were frequently discussed in conjunction with issues pertaining to communicative health problems that could affect the (white) population in the state. We argue that the vast lack of inclusion and apathetic references to Native American groups within the archives may help to explain the historical roots of some of the inequalities observed today. In the following paragraphs, we present analysis of the empirical evidence derived from the archives to illustrate the initiatives of the SDSMA and the absence of recognition of Native American healthcare needs.

Over the studied timeframe of the SDSMA, we observed the influence the Association had in healthcare policies and regulations in South Dakota. The Association made certain groups of people more relevant than others concerning health outcomes in the state, often ignoring or devaluing the Native American people of South Dakota. During the formation and development of the SDSMA, we expected to see reference to the series of changes regarding AIAN national health policies that were occurring in the late 19th and early 20th centuries, especially given the prominent population of Native American (Indians) in South Dakota. The changes at the federal level were not reflected in the decisions or

interests of the SDSMA, exhibiting a lack of institutional acknowledgment and involvement of Native American (Indian) people during these crucial stages of AIAN healthcare policy decisions.

“Proper Propaganda” and “Public Health”

Generating a sense of independence and legitimacy is important to any professional organization. However, the intense focus and success by the SDSMA make it important to note that, as the members of the SDSMA's interest in delineating themselves as a legitimized profession grew, so too did the Association's ability to garner institutional power through legislative action. The first signs of an attempt to demarcate themselves and create a standard of practice was in 1887, where talk of “quacks” and pseudo-doctors was recorded during the sixth annual session (Pahlas 1956, 8). We see similar sentiments decades later in the Proceedings of the Board of Councilors of the SDSMA (“Annual Session Proceedings” 1930, 29–31), where a member named Dr. Hohf states:

The osteopaths and the chiropractors and every damn cult want recognition, and here is one on his feet who will not recognize them. I will fight them to the last ditch if it is necessary. I know what it cost me to get where I am, professionally speaking . . . I shall not vote for anything that puts me on a parity with the chiropractor. . . . Anyway, is the influence of 350 men who comprise the organized medical forces of the state not equal to this little handful of chiropractors and osteopaths?

Within the Association at the time, members disagreed as to what approach must be taken to pass the Basic Science Bill, which called for an examination by a board in order to practice healing arts. Some believed compromise with the osteopaths and chiropractors was necessary, while others like Dr. Hohf did not, but the overall goal of passing the bill was agreed upon. This direct quotation was in response to members from a particular district that wanted to compromise. Organizational members' efforts toward establishing themselves as the only “true” medical professionals are consistently present throughout the archival documents, even including an argument for “proper propaganda”

(“Official Proceedings” 1924, 55). Along with this effort was a movement toward becoming the layperson’s expert; Association members actively worked to establish the role of medical physicians as a primary source for informing the public and maintaining the well-being of the population. Particularly, two common themes that thread SDSMA documents throughout the years studied were efforts by the Association pertaining to “sanitation” and “education.” Eventually, these terms began to fall under the evolving umbrella of “public health” in the 20th century. These trends follow scientific developments of the late 19th century, including the 1864 discovery by French chemist and microbiologist Louis Pasteur that demonstrated that microorganisms in the air are responsible for the spread of disease, which became known as the germ theory of disease causation. Pasteur’s discovery transformed the public’s understanding of sickness from an abstract and unpreventable entity into a concrete course that could be prevented if populations were educated about its modes of transmission. Overall, physicians and the scientific community wanted to ensure that the general public understood their role in the spread of disease. For example, the president of the Association writes (“Minutes” 1913, 12), “Whereas, the prevalence of disease is, in a great measure, dependent upon the lack of knowledge of the principles of sanitation on the part of the public; and whereas, the duty of the medical profession involves the diffusion of the knowledge of the principles of the prevention of disease among the laity.”

Public health lectures became a major focus of the Association, and the organization’s actions reflected this emphasis explicitly. For example, by 1914, more than 1,500 South Dakota teachers had attended public health lectures delivered by SDSMA officials. “The health of the community can be materially influenced by the intelligent teaching and practical demonstration of hygiene and sanitation in the public schools” (“Minutes” 1914, 5). In addition to educating teachers, representatives of the Association also presented to women’s clubs, college classes, farmers, and immigrant groups. Requests for speakers became so numerous that not all of them could be realized (“Minutes” 1914, 14). Another outreach effort included establishing a fund and providing physicians for the care of “crippled children” and, “before the work for crippled children was begun, a letter was sent to each physician in the state requesting the name of indigent crippled children

in his community” (“Official Proceedings” 1925, 61). This quotation highlights that significant organizational effort was expended when specific demographic groups were identified for assistance, regardless of the size of the population. These outreach events and public health initiatives targeted a number of prevalent demographic groups in the state. In some cases, the groups included members that were still largely without rights, such as women. However, there is no mention of a lecture ever being held on a reservation or an initiative meant to empower patient autonomy of Native Americans elsewhere in the state. Since no attendance ledgers were found in the archives, we cannot be certain that no Native Americans traveled to distant communities to attend these lectures. However, we suspect that geographical barriers would have prevented Native American attendance, among other social factors. While it is possible that some Native Americans may have attended public health lectures that took place off reservation land, the data studied clearly indicate that physicians traveled to reach the demographic groups that they deemed important.

The US policy preference about AIAN in the early 1900s focused primarily on assimilation, with lasting consequences on American Indian health. Other congruent policies that contributed to a legacy of abuse were the allotment of reservation land, the Bureau of Indian Affairs boarding schools where anything Indian was prohibited, and the banning of traditional ceremonies. Given that there was a strong emphasis on acculturating Native Americans, we would expect targeted and parallel “sanitation” and “education” efforts directed at the Native American (Indian) communities in South Dakota. According to Dr. Cook, some discussion of Native American inclusion in these public health movements appeared as early as 1897, at the 16th annual meeting of the SDSMA, where Dr. Fred Treon read an article titled “The Sanitation and Education of the American Indian” (Cook n.d., 3). However, no other action besides the reading of the article is noted.

In future years, when Native American health was brought up in group meetings, discussion was oriented toward the containment of diseases, as opposed to public health initiatives meant for Native American empowerment. The Association’s recognition of the health disparities of the South Dakota Native Americans did not motivate the group to address the high morbidity rates on the reservations. SDSMA gatherings of 1910 and 1914 demonstrate that isolation of tuberculosis and

trachoma—two epidemics on the Cheyenne Indian reservation—was a major focus. From the minutes in 1914: “I have asked Mr. King, the agent at Cheyenne, to be present at this meeting to present before our Association his recommendations for increased hospital facilities on the Reservation for the protection of the Indians and the removal of contagion from the white settlers” (“Minutes” 1914, 2). This quotation illustrates the Association’s recognition of the need for increased hospital presence on the reservation for the safety of both Native Americans and white settlers. However, any efforts to educate the Native American population about the implications of Pasteur’s discovery prove nonexistent. In 1910 the population of Native Americans (or “Indian” by race) in South Dakota was 19,137, while the population of the entire state of South Dakota was 583,888 (US Census 1910, 589). If health requires a completely informed public, we would suspect to see Native Americans, an important demographic group in this state, to be included in these efforts. Moreover, one might expect to see broader conversations regarding increased hospital presence across the state, so as to prevent the spread of disease between populations, yet the SDSMA highlights this as a concern only as it pertains to Native Americans not contaminating the white population.

SDSMA Priorities and Shifting National AIAN Health Policy

At the 1913 meeting, the Association recognized that geographic barriers prevented physicians on the Rosebud Indian Reservation from active participation in the nearest district’s meetings. Dr. Roane, president of the SDSMA, states, “The gentlemen on the other side of the river were very enthusiastic, and were very anxious to become organized into a separate district, because they lived so far from the meeting place of the Eighth District that it was practically impossible for them ever to attend our meetings. The official name of this group was the ‘Rosebud District Medical Society’” (“Minutes” 1913, 3). The formation of this new district highlights an organizational effort to increase representation on the Association of physicians that (presumably) were more suited to represent this marginalized population in the state. However, following the formation of the Rosebud District Medical Society, representation of Native Americans in recorded dialogue remains seldom, even during critical time periods for Native American healthcare.

In 1917, for example, the Rosebud Indian Hospital was founded, making it the first fully functional hospital on a Sioux Reservation (Thompson 2009, 424), yet there is no discussion about its formation or status in any of the SDSMA documents analyzed (“Annual Session Proceedings” 1917; Cook n.d., 6).

Shortly after, in 1921, the Snyder Act “establish[ed] health care as trust responsibility of US government for eligible members of federally recognized tribes” (Thompson 2009, 424). The Snyder Act of 1921 was the first law that allowed Congress to address AIAN health by distributing funds on a regular basis. It stated that the Bureau of Indian Affairs, under the supervision of the Secretary of the Interior, would use the funding as appropriated by Congress to the benefit, care, and assistance of American Indians through the US government, creating a framework for future funding authorities (Warne and Frizzell 2014). However, the Snyder Act did not appear to have any impact on the ideas or perspectives of the SDSMA about American Indian health in South Dakota. The Snyder Act went unmentioned in the documents examined for several years following its passing. Rather, the official proceedings of the SDSMA annual meetings of 1921, 1922, and 1923 covered topics such as membership numbers, a failed attempt to establish an institutionalized process of licensing physicians, and the establishment of several subcommittees. Furthermore, in 1923, they vehemently fought a Veterans’ Bureau action that would support training chiropractors, even sending a copy of their resolution to the US president, a Senate committee on the Investigation of the Veterans Bureau, US senators and representatives from South Dakota, and the American Medical Association (Cook n.d., 7; “Official Proceedings” 1923, 42). Their action and knowledge concerning federal policy regarding chiropractors exhibited that the Association was aware of national policy that could affect medicine in South Dakota. To have no reaction or discussion of the Snyder Act in contrast to contacting the US president over the Veterans’ Bureau training of chiropractors exhibits their priorities focused on institutional power, without any evidence of concern for Native Americans (Indians).

In 1924 the modern IHS was established as a Health Division within the Bureau of Indian Affairs (Thompson 2009, 424). During this same year, members at the Association meeting discussed the importance of continuing to delineate themselves from osteopaths and chiropractors, whom they referred to as “cults.” In particular, the

SDSMA meeting minutes read, “there is only one way to counteract the cults, and that is by education . . . by means of proper propaganda,” and “seek more publicity for the benefit of the profession” (“Official Proceedings” 1924, 55). This provides evidence of the Association’s priority to delineate itself from other related medical professions, and members of the SDSMA believed that education and publicity could serve as mechanisms through which the profession could achieve that goal.

Education and “proper propaganda” as mechanisms for legitimization continued to be a theme throughout following years while Native Americans and IHS remained absent from discussion. The SDSMA continued to generate institutional power (i.e., power and authority that were made concrete through legislative action). In 1925 the Association successfully defeated two bills that would have allowed osteopaths to practice medicine in the state hospitals and clinics, and to perform surgeries (*Journal Lancet* 1925). Just two years later, allopathic doctors from the SDSMA compromised with the osteopaths to create a bill, which was—to the benefit of the Association—vetoed by the governor (“Official Proceedings” 1927, 31).

While the SDSMA was focused on maintaining professional autonomy from other medical practitioners, the Merriam Report was published in 1928, which compared health services for American Indians to that of the general population, identifying factors to help meet a minimum standard of health. The suggestion that more money should be allocated and that IHS should be reorganized began a new era that sought policy for the good of “Indian culture ‘rather than to crush out all that is Indian’” (Shelton 2004, 8). Again, despite these influential moments in American Indian policy, discussion of this critical report remains unnoted in the formal SDSMA documentation. It is possible that conversations regarding Native Americans occurred “off the record.” However, the official discussion points of the meetings drove the actions of the Association. Therefore, it is significant that these major local and national changes in Native American healthcare were left absent from formal organizational documents. Beyond the conversations recorded at annual gatherings, we saw no representation of physicians from the Rosebud District Medical Society on any of the following committees created in 1921: Legislation and Public Policy, Education, Child Welfare, and Hospitals (“Official Proceedings” 1921, 22). The absence of physicians with experience working with Native American populations on these critical committees,

ones that had significant pull in legislative action in the state, further marginalized Native Americans.

By the 1930s the SDSMA was still locked in a struggle for institutional power among the osteopaths and the chiropractors of South Dakota (Waligoske and Travers 2018). Evidence of the group’s recognition of their desired influence in legislation was seen again in 1933. Following the defeat of the Basic Science Bill, a bill that called for an examination by a board in order to practice healing arts, members recognized that the Association must become involved in legislative processes and merge medicine and politics if they hoped to defeat the osteopaths’ and chiropractors’ attempts to legitimize their professions in the state (*Journal Lancet* 1933; Pahlas 1956, 65). Finally, after several attempts, the Basic Science Bill was successfully passed on July 1, 1939, to the benefit of the SDSMA (Pahlas 1956, 65). The bill required people practicing the healing arts to obtain a basic science certificate, which could be acquired only upon the successful completion of a comprehensive examination written under the direction of the Basic Science Board of Examiners. Anyone practicing the healing arts without this certificate could be prosecuted. The bill was therefore intended to be used as an educational barrier to eliminate the “cults” of osteopaths and chiropractors from practicing in the state.

The SDSMA’s involvement in legislation extended into the 1940s and ’50s as well, during which members were heavily involved in planning the establishment of a four-year medical school in the state, according to the transactions of the Association for 1954–56. In 1947 the Association was also involved in creating a veterans administration plan, and creating and implementing the South Dakota Plan (an insurance program for the state) that was intended to keep medicine privatized in light of emerging talk of socializing medicine (*Journal Lancet* 1947, 366–68). At the time, the Association referred to “state” medicine and even private insurance as socialized medicine, in that it removed physicians’ control and involvement from the payment process. Such developments made by the Association, in addition to the passing of legislation such as the Basic Science Bill, highlight the level of influence held by the SDSMA regarding policy and regulations in South Dakota during critical periods of time in which healthcare was being institutionalized at the state level.

Simultaneously, a steadfast focus by the SDSMA was the health and well-being of “rural” residents of the state. A continual concern for the SDSMA and their ser-

vice to South Dakota was the lack of rural physicians. In 1945, records noted one doctor per 804 people in the city, but only one doctor per every 2,542 people in the rest of the state, with some counties having no MD whatsoever (*Journal Lancet* 1945, 338; Pahlas 1956, 35). According to the president of the SDSMA in 1947, the “lack and improper distribution of physicians and hospitals” was considered the Association’s “most serious problem” (*Journal Lancet* 1947, 377). Taking steps to address this issue, the Association established a service in 1950 that would “facilitate placement of rural physicians,” including the provision of assistance to physicians in rural areas lacking the services found in larger cities (Pahlas 1956, 36). By doing so, the group showed their willingness to locate a population underserved by the medical community (specifically, the rural communities of the state) and devote resources and attention to combating the problem of physician shortages in these areas. This stands in stark contrast to the lack of mention of Native American (Indian) health initiatives or programs, even during the active national conversation about American Indian healthcare during this time. Our interpretation that the organization’s emphasis on rural communities can be normatively understood as separate, or mutually exclusive from Native American communities, reflects the patterned ways that AI, if mentioned, are explicitly identified within the archival data.

By the 1950s, the federal stance on the Bureau of Indian Affairs was resorting back to an emphasis on assimilation. The Hoover Commission’s “Task Force on Indian Policy” introduced policy related to the shifting desire to integrate American Indians into the larger US population; it included a suggestion that social programs for American Indians should be transferred to state governments and for the weakening of the Bureau of Indian Affairs (Kunitz 1996). The steps to achieve assimilation involved encouragement to move American Indians from reservations to cities and to remove responsibilities from the Bureau of Indian Affairs to the Public Health Service. The sponsor of the House bill, Representative Walter Judd of Minnesota, was a physician who said that the idea for the transfer bill came to him from the American Public Health Association meeting in 1951 (Kunitz 1996).

The bill passed with the intention to create the only true national health service for American Indians, providing almost a full range of public and personal services. This bill, the Transfer Act of 1954, placed the Indian health program under the Public Health Ser-

vice responsibility. While other legislation at the time focused on eliminating policies that separated Native Americans from the rest of the US population, the Transfer Act was unique in that it created a specific insurance plan for Native Americans. Although assimilationists favored the bill due to the weakening of the Bureau of Indian Affairs, this transfer of governmental organizations also helped recognize tribal sovereignty and facilitated some tribal self-determination in health policy decision-making (Warne and Frizzell 2014). Additionally, the bill allowed physicians and dentists to fulfill compulsory military obligations with service on Indian reservations (Thompson 2009). This ability to fulfill the (then compulsory) US military obligations through medical service on Indian reservations—as opposed to other locations overseas in potentially active conflict regions—bolstered a temporary influx of physicians to serve needs on reservation facilities. However, when compulsory military duty in the US ended in 1972, medical doctors and dentists “fle[d] from reservation environments, forcing IHS and tribal officials to enlist other medical personnel” (Thompson 2009, 425). These prior institutional shifts contributed to the continued challenge of sufficiently and consistently having enough medical professionals present to serve Native Americans living on reservations.

During this active time of national conversation regarding ideas about the Bureau of Indian Affairs and American Indian health services, the records of the SDSMA were surprisingly yet tellingly mute concerning American Indian healthcare in South Dakota. In the years 1954–56, despite the significant national attention given to the influential Transfer Act, we find no mention of the bill in our reviewed materials of the transactions of the SDSMA. In the annual meeting programs during these years, and in materials throughout the 1950s, no evidence appeared of discussion of the new bill or its consequence to South Dakota American Indians and physicians. The 1954, 1955, and 1956 publications of the *Transactions of the South Dakota State Medical Association* included reports from the Committee on National Legislation. In each year, no mention was made about the Transfer Act. During the year of its passing, 1955, the report instead focused on the opposition of insurance legislation and the American Medical Association’s support of the Bricker Amendment as a method to combat the potential for socialization of medicine through treaty alone. Outside of legislation, the SDSMA emphasized issues such as the advancement of medical education

in South Dakota and the increase of the South Dakota Medical School Endowment Association to strengthen the state's control over medicine in South Dakota as well as to increase physician numbers in the state. Two years after the Transfer Act passed, among the 42 committees and subcommittees adopted by the SDSMA House of Delegates, there continued to be no reference to the Transfer Act or to Native Americans and healthcare among the group's documented priorities (*Transactions* 1956, 294–305).

The few references to Native Americans that did emerge during this era of the SDSMA displayed the distance and apathy given to the distraught group by the medical professionals of South Dakota. The April 1949 issue of the *South Dakota Journal of Medicine and Pharmacy*, published by the Association, includes a report that references the testing of a tuberculosis vaccine (in two different studies) on “3,008 Indians on 4 different reservations” and “about 4,000 infants and siblings in the poorest living districts of Chicago” (148). Arguably, the extent to which American Indian tribes are prevalent communities within South Dakota might lead us to expect that at minimum, a brief discussion or acknowledgment within the article regarding the specific testing that took place on American Indians might be appropriate, especially given that they are seldom referenced. Two years later, in 1951, the August issue of the same journal blamed American Indians for misconstruing progress in death rates related to tuberculosis, while also echoing sentiments about American Indian health from the early 1900s. The committee responsible for public health writes that “the slow drop in the death rate is largely due to the high rate among the Indian population. Perhaps this can only be controlled by more intensive education among the Indians and more strict isolation” (203). The call for isolation of the Native Americans mirrors the language used by the group decades earlier when referring to protecting the white settlers from contagion. In the December 1947 issue of their monthly editorial *This Is Your Medical Association*, a notification appeared that a project in the Canton-Inwood area of South Dakota included a call for rebuilding the Indian Service hospital near Canton. No further mention of these plans appeared in later meetings. As a final example, exhibiting the Association's understanding that American Indians were considered a population significant to South Dakota, a SDSMA member spoke out during a regional conference, as noted in the December 1947 *This Is Your*

Medical Association newsletter. In his account of his speech at the meeting, the physician recalled speaking “briefly—enough to let them know that we have something besides pheasants and Indians out here” (28). Despite the Association's acknowledgment of the significance of Native Americans to the identity of South Dakota, and the high rates of illness on the reservations, Native American groups remained low on the priorities of the SDSMA.

Conclusions

Throughout the reviewed documents, the persistent absence and indifference toward Native American involvement in the SDSMA signaled a lack of institutional value placed on the consideration of Native Americans and their lived experiences. While the medical association showed strong involvement in legislation affecting the practice of allopathic medicine in South Dakota, no mention of any major Native American health initiative was seen, even during periods of significance to Native American healthcare, such as the formation of the Indian Health Services and the Transfer Act of 1954. Instead, as one might expect, during the early formation and development of SDSMA group (1882–1909), issues tied to growing membership were a key focus. Secondary emphasis was placed on the dissemination and cultivation of basic scientific awareness regarding germ theory and the foundational idea that illness can be contagious and spread among individuals because of the existence of bacteria and other microorganisms. The public health education movement focused on ensuring that South Dakotans—most likely excluding Native Americans—understood how germs were relevant and diseases spread. Many of the initiatives were coined “sanitation” and “education” efforts, and in conjunction, the SDSMA also urged the public to recognize medical doctors as experts in health-related issues, given the scientific underpinning of the profession.

Furthermore, the archived history of the SDSMA exhibited contemptuous relationships with competing practices of medicine, particularly chiropractors and osteopaths. Early delineations between medical doctors and chiropractors were drawn despite the lack of educational standards for medical practice which would not occur until well after the Flexner Report of 1910. Cultural tropes among members of the Association were already being circulated as early as the late 19th

century denouncing the “quacks” of osteopathic medicine (Pahlas 1956, 8). The value placed on gaining power within medicine’s institutional hierarchy coupled with the vacancy of mention of Native Americans begin to reveal priorities that have generated inequalities, becoming crystallized over time.

The SDSMA is a voluntary professional association that successfully gained power and influence over local policies. This fact provides an important glimpse into how the development and maintenance of professional organizations may play a crucial role in exacerbating inequitable conditions. By examining archival collections pertaining to the development and institutionalization of a formal governing organization of medicine in the state of South Dakota, we can provide evidence of the ways that institutional structures evolved, and more specifically, the ways the SDSMA failed to sufficiently acknowledge, represent, or engage with Native Americans during this process. Scholarship on the historical evolution of the power, authority, and influence of medicine and medical professionals (Starr 1982; Swenson forthcoming), including recent work on physicians’ and medical organizations’ role in policy (Beyer and Mohideen 2008; Laugesen 2016), has illustrated the importance of examining the command that professional associations in medicine continue to possess. As Miriam Laugesen notes in her book, *Fixing Medical Prices: How Physicians Are Paid* (2016), physician organizations are at the center of political work influencing how prices are determined for services. Moreover, she argues that despite the complexity of contemporary systems wherein many social actors are contending to influence policy, “organizations representing physicians continue to be powerful rather than weak,” and the “House of Medicine,” or organizations representing US physicians (Laugesen 2016, 5–6), continue to exert power, although through less visible ways via “quiet politics” (Culpepper 2010). Relatedly, medical practitioners and interdisciplinary scholars are beginning to examine how medical associations beyond the American Medical Association—including state-level, specialty, or local/regional associations, and non-US entities—may have organizational influence on healthcare policy (Brophy and Sriram 2019).

Our findings suggest that an absence of representation of interests or experiences of marginalized groups (specifically Native Americans) within medical organizations such as the SDSMA signify that these organizations and their evolution are significant contributors to the endemic inequalities that continue to exist today in

healthcare systems. While our empirical data are historic in scope, we assert that our findings have implications that are relevant to the current role that local state-level medical associations like the SDSMA may have in shaping disparate health outcomes for groups in contemporary society, either through their deliberate actions or their inactions (intentional or not). This critical analysis highlights the value of involving or at the least considering how Native American people have differentially inequitable experiences with healthcare systems. To address this, we suggest that going forward, social actors involved in health policy, service, and delivery, including voluntary medical associations like the SDSMA, need to sustain an integrative focus on Native American perspectives. More specifically, in recent years community-based participatory research (CBPR) has developed into a prominent approach to incorporate the experiences and perspectives of community members that have often not been fully recognized in prior research. Broadly defined CBPR endeavors are promising because they aim to facilitate more equitable circumstances between diverse, often marginalized, communities and academic partners through two-way knowledge transmission in research (Wallerstein and Duran 2010). Similarly, in critical scholarship on First Nations peoples in Canada, self-determination applied to research is identified as essential to future undertakings, and particularly the processes of ownership, control, access, and possession (OCAP) are highlighted as necessities for “rebuilding of trust, improved research quality and relevance, decreased bias, meaningful capacity development, and community empowerment to make change” (Schnarch 2004, 80). We assert that our findings regarding the priorities of the SDSMA during early historical periods of the Association align with this call and hope that by uncovering and drawing attention to the inequities embedded in the organizational development of the SDSMA, we are contributing to future OCAP of this knowledge by Native Americans.

Finally, going forward, we propose that a crucial aspect in addressing Native American inequities is the explicit acknowledgment of the longstanding legacy of exclusion. The lack of care for, attention to, or inclusion of Native Americans during the development of programs central to their well-being has been devastating to the functioning of institutional systems intended to aid this population. This systematic and pervasive history of exclusion and disregard for Native American peoples necessitates a larger scope when problem-solving con-

temporary healthcare issues. Subsequently, broadscale changes would need to be implemented and nurtured over longer periods of time, stretching well into the future. To ameliorate the problem and actualize significant change, we suggest that leaders move beyond the approach of retooling a single policy or practice, or of merely balancing an operating budget for a few fiscal years. Instead, if we want to learn from the past and begin to fix the persistent health inequalities that exist for Native Americans today, the new norm must be long-term goals that (1) account for the gradual process of change, (2) acknowledge other interrelated social structures that influence experiences for Native Americans, and (3) include as central the experiences and voices of the people such policies are intended to serve.

Methods Appendix

During the exploratory phase of research, we began by examining three primary documents to create a rough timeline of the SDSMA and map key events or changes. The documents include association member Dr. J. F. D. Cook's "Historical Sketch of the SDSMA," which is undated but references the 49th Annual Meeting in 1930 (Cook n.d.); a (bound) master's thesis by Clark Jaye Pahlas on the history of the association from 1882 to 1956; and what is presumed to be a draft of the thesis (unbound), based on a line-by-line comparison of the two documents (Pahlas 1956). All three documents were kept by the association. Reviewing the member's historical sketch and graduate student's work aided in a general understanding of the development of the organization including how the organization incorporated various geographic areas for membership and its role as a prominent health authority in the state of South Dakota. Subsequent secondary research on AIAN health policies or major shifts in such policies leads us to conclude that adhering to the same time period (1882–1956) was appropriate for the analytic scope of our project. While the graduate thesis also examined the historical sketch by Dr. Cook, and other primary documents from the SDSMA collection, our analytic lens on the archival materials is substantially different. In particular, the graduate thesis explored dimensions of professionalization typical to voluntary professional associations and took for granted the considerable work that the association had to do to gain institutionalized power and influence over state legislation and related poli-

cies. The thesis did, however, provide us initially with a broad timeline spanning the years of 1882–1956 that highlighted moments of influential action by the Association including dynamics between physicians and other practitioners. Ultimately, this aided in our ability to begin to identify and map changes to the priorities of the SDSMA. Another significant difference between our archival research and cultural analysis compared to the other two authors' documentation of the Association's history is our attention to the presence and prevalence of Native Americans within the archives. While there was mention of Native Americans, they were not a systematic focus by either author.

During the second phase of data collection we subsequently examined various archival materials addressing the years 1861–1958 but focused on 1882–1956 to reconstruct a more complex timeline of the activities, attentions, and intentions of the association. By honing in on this period we were able to identify major federal legislative happenings such as the establishment of the Snyder Act in 1921 and the creation of the Indian Health Service in 1924, and to consider how those changes were (or were not) addressed by the state association. In contrast, by looking more closely at the 433 pages of archival materials, we then could identify approximately 150 initiatives, agendas, and discussion of various priorities that were made prominent for debate in formal meetings, discussions, or councils. Of those 150 times priorities or other initiatives were discussed, Native Americans or the aforementioned themes came up approximately 10 times, including more than two instances referring solely to the attendance of physicians from the Rosebud District. The remainder of our analytic reconstruction of the SDSMA priorities focused on noting instances that we would have expected to see some acknowledgment or discussion of Native Americans given either national events or legislative changes, or because of the attention provided to other groups in the state regarding various initiatives.

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Who Owns Wells in Kansas?

An Exploration of Rural Water Supply Reliance in the High Plains

Brock Ternes

ABSTRACT—Intense demands for irrigation water have consumed massive amounts of groundwater in Kansas, where the High Plains aquifer is being depleted. This study investigates the ownership of private water wells across the state and summarizes well owners’ demographic information. My guiding research question is, Who are Kansas well owners? To answer this, I surveyed the demographics of well owners and non-well owners throughout Kansas ($n = 864$). The project controls for water supply infrastructure and exposes many differences among Kansans when assessing commonly studied demographics (sex, income, political affiliation, education, age, and geography). Kansas well owners appear to be wealthier, older, better-educated, and more politically conservative than their non-well-owning counterparts.

Key Words: groundwater, High Plains aquifer, Kansas, water supply infrastructure, well owners

Introduction

Groundwater levels all over the world have been rapidly declining, and observations indicate that a third of the largest aquifers on the planet are overstressed (Richey et al. 2015). The depletion of aquifers (underground reservoirs of freshwater) is a leading cause for global water shortages, and groundwater declines are one of the main hydroclimatic hazards of droughts, which are exacerbated by global warming (Kallis 2008). Aquifers are a critical supply of freshwater and remain the greatest defense against droughts in many water-scarce areas. While aquifers have sustained agriculture, urbanization, and drinking supplies globally, researchers anticipate a growing reliance on groundwater sources that are already stressed (Famiglietti 2014).

One of the largest aquifer systems in the world, the High Plains aquifer, has undergone severe declines on

account of extreme droughts, heat waves, and the extractions from irrigation wells. This massive groundwater formation is located primarily in the central United States and underlies eight states (see Fig. 1). The High Plains aquifer technically refers not to a single aquifer but to multiple ones; it contains three individual aquifers in Kansas alone: the Equus Beds and Great Bend Prairie aquifers in south-central Kansas, and the expansive Ogallala, which occupies far western Kansas and extends into several neighboring states. The High Plains aquifer is a gigantic underground network that can be more accurately described as a system rather than a single groundwater formation. It has multiple segments that react differently to *overdrafting* (the removal of water from an aquifer faster than it can be regained) and *recharge* (the natural percolation of surface water into groundwater sources). The imbalance between recharge and withdrawal has been so severe that the central and southern portions of the aquifer are experiencing enormous declines (Haacker, Kendall, and Hyndman 2016). Moreover, the region overlying the High Plains aquifer is undergoing dramatic climatological shifts: recent

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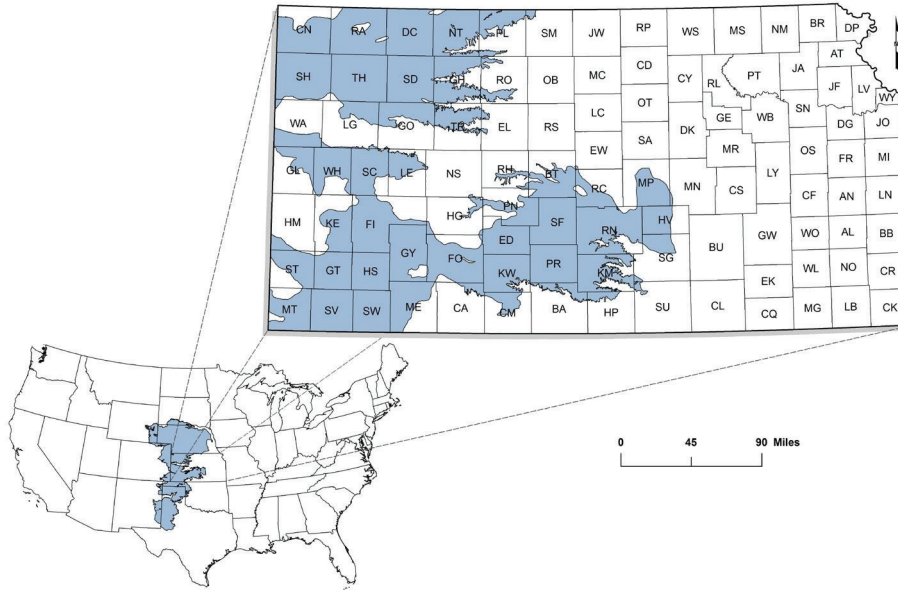


Fig. 1. The High Plains aquifer. Source: Buchanan et al. 2009.

work (Roberts et al. 2019) on spatial regime movements indicate that the boundaries of the North American Great Plains have moved hundreds of miles northward since 1970 due to climate change, energy development, and land use changes. The state of Kansas's portion of the High Plains aquifer contains some of the worst recharge-to-extraction ratios in the entire system, and low recharge rates make parts of the aquifer essentially nonrenewable (Padgett 2013). If current rates of extraction continue, the aquifer will be 69% depleted by 2060 (Steward et al. 2013).

As a whole, the High Plains aquifer has been overpumped for its valuable irrigation water. Extractions from tens of thousands of high-capacity irrigation wells have mined groundwater supplies in Kansas for 70 years. Unless withdrawals are seriously curtailed, Kansas will remain “extremely vulnerable to the occurrence of drought” (Logan et al. 2010, 255). This has profound implications for sustaining global food production, as the region over the aquifer comprises the largest irrigation-sustained cropland on the planet, making groundwater in the High Plains essential for agriculture (Peterson and Bernardo 2003). In 2013, the irrigated corn and wheat grown in southwest Kansas was valued at nearly \$1 billion (Buchanan et al. 2015). Projections indicate that the climate of the High Plains will produce warmer droughts, which implies that many Kansans will have to

survive harsher summers with smaller reserves of groundwater.

The exploitation of water resources has long motivated Kansans to establish legal restrictions for groundwater extractions. In 1972 Kansas created five Groundwater Management Districts (GMDs) to supervise well extractions. These districts are five areas that overlie certain portions of the High Plains aquifer and their purpose is to encourage water rights holders within their boundaries to use irrigation water prudently and

improve their awareness of extractions (see Fig. 2). The GMDs are organized by area landowners and large-scale groundwater users, and they attempt to extend the life of the aquifers by limiting irrigators' water allocations and establishing safer yields for groundwater removal. Local management is in the hands of GMDs, which were created to establish the “right of local water users to determine their own destiny with respect to the use of the groundwater” (Fund 1993). Each GMD has a board of directors who represents the district's water users. Board members are elected every three years and are responsible for fairly assessing groundwater management needs and adopting new policies to meet those needs (Equus Beds GMD 2013). More specifically, the districts restrict new (junior) wells more than the wells of the established (senior) users. GMDs allow local landowners and water users to be directly involved in regulating and restricting their groundwater withdrawals. Approving new appropriations, regulating well spacing, requiring meters on new water rights or wells, and providing newsletters, presentations, and other public outreach and educational efforts are some of the responsibilities of GMDs (Bossert 1993). GMDs 2 and 5, which overlie the Equus Beds aquifer and Great Bend Prairie (aka Big Bend) aquifer, respectively, manage the aquifers based on safe yield policies, meaning that the water rights cannot appropriate more water than is recharged into those aquifers (Buchanan et al 2015).

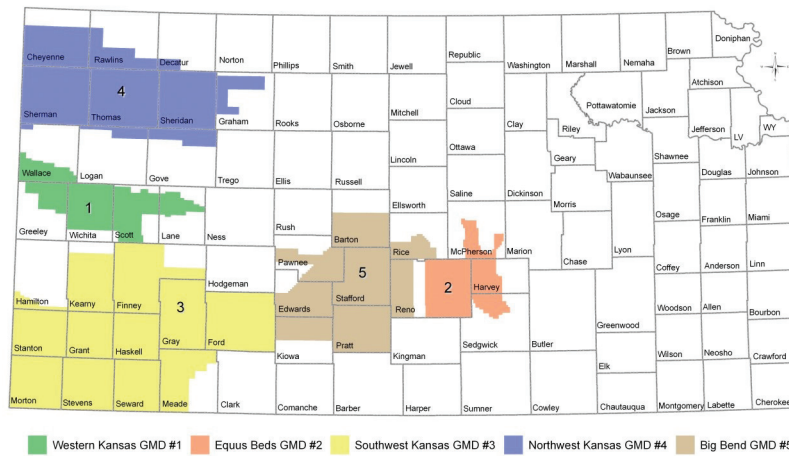


Fig. 2. Kansas Groundwater Management Districts (GMDs). Source: Kansas Department of Agriculture 2014.

Overall, many political efforts addressing water table declines across the High Plains and the semiarid West have emerged at the state level. Nebraska created 23 Natural Resources Districts (NRDs) in 1972 to coordinate resource conservation and protect surface and groundwater supplies through Integrated Management Plans (IMPs) (NARD 2018). A 2015 water settlement agreement plan in Idaho's Eastern Snake Plain Aquifer region requires groundwater irrigators to reduce their watering by an average of 13% (Running, Burnham, and du Bray 2019). Ambitiously, the High Plains Underground Water Conservation District in Texas has agreed to cut its pumping by 28% (Postel 2012). Similarly, in northwestern Kansas, irrigators in GMD 4 have agreed to reduce groundwater pumping by 20% (Malewitz 2013). GMD 4 then went further to expand a Local Enhanced Management Area (LEMA) to the entire district in 2018. This means that in areas where groundwater levels are declining or the rate of withdrawal equals or exceeds recharge, the district can set goals and control measures to conserve groundwater. As Kansas policymakers consider drought resilience policies, contextualizing water usage within specific groundwater formations will play a large role in how Kansas utilizes its water supplies.

Currently, Kansas state law mostly focuses on high-capacity irrigation wells, but evidence suggests that low-capacity wells can also contribute to groundwater losses (Wilson et al. 2008). Any extractions exceeding recharge are not safe and could jeopardize aquifer-based communities. Competition for water will remain a key struggle for decades, especially as climate change has a

“growing impact on agriculture due to changing rainfall patterns . . . warming temperatures, aridity, and greater uncertainty” (White 2013, 109). High-powered wells are not only a unique part of water supply infrastructure used by many communities; they are the interface whereby humans modify groundwater supplies. The proliferation of high-capacity wells can be regarded as a development of productive forces that influence the conditions of production, as powerful well pumping technology enables the rapid extraction of groundwater, and they are critical to the cultural landscape of the Great Plains. Their pre-

ponderance changed farming in the High Plains; wells are the sites of interaction between subterranean freshwater and food production in semiarid climates. Despite their importance, little is known about Kansas well owners as a population. To fill that lacuna, this study offers a description of their demographics.

Research Agenda

Sustaining the High Plains aquifer requires an investigation of the individuals reliant on its groundwater. This research probes how water supply infrastructure is associated with demographics of Kansans. My central research question is, Who are Kansas well owners? I hypothesize that demographic variables (including sex, income, political affiliation, education, age, and geography) will shift as groundwater reliance enters the picture. This article explores the demographics of Kansans while controlling for differences in water supply infrastructure.

Studying the demographics of rural water supply infrastructures has important implications for rural communities, since groundwater is the drinking water source for 90% of the rural population in the United States and 80% of rural Canadians (Lemley and Wagenet 1993; Expert Panel on Groundwater 2009). Private well owners are susceptible to groundwater contamination and reduced well yields, and they are disproportionately burdened by groundwater loss compared to citizens with municipally provided water. The next section out-

lines the literature studying well owners, and I show how empirical reflection on the sources of variation in rural demographics remains limited.

Literature Review and Framing

With the exception of a handful of case studies and surveys focused on populations in Asia (Dhawan 1987; Kumar, Singal, and Rath 2004; Shah, Singh, and Mukherji 2006), well owners constitute an important subpopulation that has not been closely studied in the social sciences. For a global perspective on well users, consider that over 25% of people on earth rely on groundwater supplies for their drinking water (Black 2004; Richey et al. 2015). In India, groundwater is the drinking supply for 90% of rural residents and 50% of urban residents (Nigam et al. 1998). One of the first surveys of Indian well owners was published as recently as 2006 (Shah, Singh, and Mukherji 2006), but even that did not provide demographic information other than proclaiming that well owners are mostly farmers. Dubash's (2002) work on well owners in India outlines how wells shape social relations, agricultural production, and agrarian institutions, which in turn govern access to economic development for rural communities. While well owners have been given some attention in the international literature, they have not been closely studied in the Midwest. Even though domestic wells provide drinking water for 200,000 Kansans, they are not adequately researched or monitored.

In the United States, many publications discussing well owners are newspaper articles focused on issues like well vulnerability to water supply contamination and water rights (Richards et al. 1996; National Driller 2002; Brownstein Hyatt Farber Schreck 2009; Agricultural Week 2011), while contamination-related studies have surveyed private well owners (Lewandowski et al. 2008). Since groundwater can be polluted by fertilizers, bacteria, and runoff, and the Safe Drinking Water Act does not protect self-supplied sources, *well owners are responsible for testing and monitoring the quality of their water supply*. Agricultural runoff is the single biggest source of water pollution in the US, so farmers (especially those with domestic wells) must “self-police” neighbors’ land use decisions in order to protect their groundwater supplies (Prud’Homme 2011). Nitrates can enter drinking water supplies via fertilizer runoff, and are a growing threat for well owners across the nation.

Aquifers are challenging to clean once they are polluted, in part because groundwater travels slowly, and it takes years for contaminants to degrade or become assimilated. Contamination issues are not quickly resolved, which makes runoff and pollution potential problems for well owners—and private wells are the owners’ responsibility to test.

In order to manage their water supply, well owners perform multiple well-monitoring routines. Assessing agricultural runoff, well yields, pumping costs, depth to the water table, and water quality are all practices associated with well ownership. Well owners therefore constitute a community of practice (Lave and Wenger 1991; Wenger 1998), a group defined by similar routines and boundaries of performance. For the purposes of this study, well owners, who are more directly involved with operating their private water supplies, need to be studied as a group of citizens that has insight on sustaining groundwater supplies.

I contend that private well owners, who are responsible for managing their own water supply, represent a subpopulation particularly vulnerable to drought, and my research explores well owners’ demographics. In a way, epidemiologists who study well owners have already adopted well ownership as a sociodemographic characteristic (Murti 2012), only a handful of sociological publications have done so (Ternes 2018; 2019; Ternes and Donovan forthcoming). Nearly 20 million people in the United States are sickened by waterborne bacteria each year, making the quality of water supplies an important field within epidemiology. Health researchers have framed well owners as a vulnerable population due to their exposure to contaminated groundwater sources (Schwartz et al. 1998; Imgrund, Kreutzwiser, and DeLoe 2011; Murti 2012). Well owners are particularly challenged by groundwater contamination; managing private water supplies is critically important for researchers studying wastewater treatment and groundwater contamination, and their studies survey well owners to assess their perceptions of water quality (Schwartz et al. 1998). The USGS National Water-Quality Assessment Program determined that roughly one in five wells used to provide household drinking water nationally have at least one contaminant present at concentrations higher than the EPA’s Maximum Containment Levels (MCLs) or USGS Health-Based Screening Levels (DeSimone 2009). Private water systems account for over 95% of the EPA’s water-related health violations; in California, one in six wells pump from water supplies that exceed feder-

al water quality thresholds (Prud'Homme 2011). Around 30% of waterborne disease outbreaks during 1999–2002 were attributed to contaminated domestic well water (DiSimone 2009). These health concerns reveal a need to increase awareness among rural households with private supplies and septic systems, especially since they are responsible for maintaining those materials.

As a part of its recently established Private Well Initiative (PWI), the Centers for Disease Control and Prevention (CDC) works with state and local health departments to conduct research on private well owners. It includes a group of researchers who distribute newsletters, hold monthly webinars, and make online presentations in a forum called the *Private Well Community of Practice* to address the critical need for safe private well water (Kirkland and Hurd 2015; Susca and Rigrod 2015). The CDC's Division of Environmental Hazards and Health Effects shares research updates in the hopes of protecting these unregulated drinking water systems, which are not under the provision of the Safe Drinking Water Act. Private wells are at the highest risk because they are not subject to state and federal testing and treatment requirements, unlike public utilities. While the CDC researchers' concerns about well contaminants are necessarily targeted at domestic wells that supply drinking water, they work to promote effective strategies to address any risks associated with well ownership.

One promising test site for this study is Sedgwick County, which has 65,000 wells alone—one-quarter of all the wells in Kansas. Sedgwick County contains the state's largest city, Wichita, which increased residential water rates over the drought years of 2011–2015. Incidentally, virtually all the wells recently constructed in Wichita are listed as “lawn and garden” wells. Despite Kansas's groundwater regulation, which mostly focuses on high-capacity wells, the groundwater withdrawals of domestic wells are not monitored and do not have to follow water rights restrictions. Consider an example from the easternmost Groundwater Management District, GMD 2, which overlies the Equus Beds aquifer: in an effort to better understand groundwater withdrawals, GMD 2 has recently required *all non-domestic wells* in the district to be metered by the end of 2015 (Equus Beds GMD 2013). Although this move is an important step toward tracking groundwater extractions, it still excludes domestic consumption. Kansas only monitors high-capacity wells, but other High Plains states (Wyoming, Colorado, and New Mexico) require permits for all wells, including domestic wells (Ashworth 2006).

Since low-capacity wells used for domestic functions do not require permits in many parts of the state, one could conceivably augment their supply without acquiring additional permits if they relied on domestic wells. I refer to this reliance on low-capacity wells to sneak around permitting restrictions, or the expenses associated with relying in public water as the “domestic well loophole.” If low-capacity wells do not need permits and do not have to comply with most watering restrictions, lawn and garden wells can be installed to bypass lawn watering restrictions and avoid water rate hikes. To investigate the spectrum of different well functions, I distributed surveys to owners of different types of wells (domestic, lawn and garden, irrigation, and livestock).

Drawing from infrastructural and epidemiological scholarship, my study aims to assess demographics among Kansans with different water supply systems. As the climate of the High Plains becomes less predictable, communities prone to drought must acquire a precise understanding of the public's conservation efforts to prepare for a new hydrogeologic reality defined by more frequent, intense water shortages. Studies have investigated well owners, but less attention has been paid to the intersection between demographics and water supply infrastructure. I conducted an online survey of well-owning and non-well-owning Kansans to explore these matters.

Methods

In order to study well ownership, I mailed over 7,000 notification postcards inviting Kansas well owners to participate in an online survey that measures their household water supply, demographics, prioritization of water conservation efforts, frequencies of various pro-environmental behaviors, and if applicable, how they use their well (IRB # 00001050). I obtained the well owners' home addresses from the Kansas Geological Survey (KGS) database of well completion records, which includes all the wells dug by well-drilling companies since the 1970s in the state. The demographic variables measure respondents' sex, age, education levels, political views, religious beliefs, marital status, race, residential/housing information, occupational and earnings information, and parenthood status. The KGS database of well completion forms allowed me to access a range of respondents who use wells: avid gardeners, ranchers, farmers, and domestic well owners. I also

attempted to sample a modest number of former well owners, as the database contains records of the wells that have been plugged.

Furthermore, I attained a sample of 420 Kansans from the online survey company Qualtrics, which had a high percentage of non-well owners. Qualtrics uses a sampling frame from the Survey Sample International's (SSI) multisourcing panel recruitment model, which has a large number of diverse frames that generate representative random samples. This random sampling allows me to conduct research generalizable to Kansas and compare well owners and non-well owners. Respondents were given awards through the SSI's recruitment system, which are points that can be traded for SSI's incentives in the form of cash, prizes, charity donations, or sweepstakes. My research assistants and I collected thousands of well owners' addresses as part of their course credit in an individual undergraduate research course, a process that spanned three semesters and required seven research assistants. After scanning the addresses for deliverability at the post office, 7,037 were sent and the undeliverable addresses were removed from the address pool.

Results

Well owners' demographics are unclear due to a paucity of previous social science research, and the goal of this manuscript is to impart such insight for this subpopulation. By scanning hundreds of names of well owners in the KGS online database of well completion forms, I estimate that two-thirds of private well owners in Kansas are individual men. Couples, small businesses, feedlots, churches, and cities also own a sizeable portion of wells, perhaps 25%–30%, and roughly 5% of private wells are owned by individual women. Roughly four-fifths of the wells in the database are located in the drier areas of the state and are above the Ogallala, Great Bend Prairie, and Equus Beds aquifers, and judging from the addresses provided, most high-capacity well owners live outside towns in central and western Kansas, a distribution that has been previously acknowledged (Evans 2013; Kansas Geological Survey 2013). This distribution makes sense because the western parts of the state have scarce rainfall and are more reliant on groundwater.

This survey is one of the only quantitative datasets on well owners used for social science research. I collected survey respondents with three solicitations: the panel

obtained via Qualtrics, the first wave of surveys to well owners in March 2015, and the second wave of surveys to well owners in early May 2015. My overall response rate for the postcards sent to well owners was 6.3%, which produced 444 respondents. The entire dataset is comprised of 864 respondents, 452 non-well owners (52%) and 412 well owners. Of those well owners, 20 are former well owners, 143 are without municipal water supplies, and 249 have both wells and municipal water. Most of the well-owning respondents own small-capacity wells: 145 (35%) are domestic well owners; 135 (33%) own lawn and garden wells; 66 (16%) are feedlot well owners; 61 (15%) are irrigators. Nearly half of my respondents (44%) live in GMDs, which are located above the High Plains aquifer (see Table 1). Geography is critical when describing access to groundwater in Kansas. While three-quarters (74%) of the non-well owners in my sample live outside GMDs, a majority of well-owning respondents (57%) live in GMDs. A noticeable amount of well owners (37%) live in GMD 2, near the Wichita area. I received replies from 93 of the 105 counties in Kansas.

Two-thirds of the respondents are married or engaged, with a substantial majority of well owners (80%) being married or engaged (Table 2). This is a racially homogeneous sample, which is to be expected in a predominantly Caucasian state. Nearly 95% of well owners and 87% of non-well owners are white, resulting in a sample in which 90% of the participants are white (Table 3). Overall, my sample has a balanced sex distribution; 47.8% of the respondents are men (Table 9). The sampling procedures used by Qualtrics equalized the sex distribution for my study, as the non-well owning sample is predominantly female (65%) while the well owners are just over 60% male. In this study, well owners are older than non-well owners and mostly clustered around their late fifties and early sixties; their mean age is 57, compared to 46 for the non-well owners (see Table 10). Approximately one-third of non-well owners are under 35, as opposed to just 9% of well owners. As it happens, the average age of Kansas farmers is 59, and only 7% are under 35 (Johnson 2016). The ages of well owners in this study closely mirror that estimate, which implies that this dataset is relatively generalizable. Recent focus groups of well owners in the Midwest and South also reported that most well owners are older (Murthi et al. 2016), and these findings mirror previous demographic assessments.

Since well owners tend to be older than non-well owners, it is likely that their occupancy in more ad-

vanced stages of the life course intersect with many other demographic variables—a longer life affords more time to go to college, get married, have (more) children, get promoted, buy a house, and the like. Well owners have more education (52% have a bachelor's or graduate degree as opposed to 37% of non-well owners; see Table 11) and this could partially be a function of the age differences between these groups. Parenthood is also a demographic variable that differs across these subpopulations. One-third of non-well owners do not have children as opposed to 15% of well owners; well owners also have larger families (about half of well owners have three or more children). Moreover, age likely overlaps with parenthood, because 72% of well owners have no children present, indicating that they are more likely to be empty nesters than non-well owners (53% of non-well owners have at least one child in the household; see Tables 12 and 13). Employment status differs across these populations. All of the full-time students in my sample are non-well owners, as are all but one of the unemployed respondents. Roughly 28% of well owners are retired as opposed to 18% of non-well owners. Half of the non-well owners are working full- or part-time, compared to 63% of well owners. Furthermore, 56% of employed well owners have employment related to agriculture. In this dataset, 29% of the employed respondents work in agriculture (Tables 14 and 15).

Organizing the respondents by income provides a nuanced picture of well ownership and class. The modal household income category for non-well owners is \$20,000–\$39,999, which is probably related to this group's age and education levels. Well owners who have no municipal water supplies have a bimodal income distribution; with \$40,000–\$59,999 and \$150,000 or more being the most common ranges of household income. Well owners who have municipal water supplies are also wealthier than non-well owners, as their modal household income range is \$100,000–\$149,999 (Table 4). Homeownership and residing in a one-family detached house is extremely high among all groups of well owners (approximately 95%), while just 4% of well owners are renters. Three-quarters of non-well owners live in a one-family house and two-thirds own their home. Across both groups, the modal population of the household is two people (see Tables 5 through 7). These findings match previous research on well owners, which notes that well users range from low to high income—although that was only known anecdotally and there are not many sociodemographic studies of well owners

(VanDerslice 2011; Fox 2016). Relatedly, even community water systems, which serve most of the US population, are not required to compile the demographics of their customers. Therefore, robust assessments of water supply disparities across sociodemographic lines are challenging for analyzing both populations reliant on private and public watering supplies.

Slight political differences can be detected across these groups (Table 8). Well owners' modal description of their political views is "conservative" while non-well owners most frequently describe theirs as moderate. Just 3% of these respondents define themselves as "very liberal." Throughout my work, I use the term politically conservative to include mainstream conservative policymakers in Kansas, who typically adopt both neoliberal values (generally, reducing the role of government and emphasizing market-based solutions) and neoconservative values (broadly, to use the state to promote a traditional value system in order to protect the cultural and ideological standards of the nation). This definition transcends Trumpism.

Well owners appear to be more religious than non-well owners: one-quarter of non-well owners are non-religious, atheist, or agnostic, as opposed to 13% of well owners. The religious well owners are primarily Protestant and Catholic. When it came to religious *identity* (which included "Born-Again," "Charismatic," "Evangelical," "Mainline Christian," and so forth), "None of these," "Bible-Believing," and "Born-Again" were the most frequently selected religious identities for all of my respondents. It should be noted, however, that non-well owners did not identify with any of the religious identities options at slightly higher frequencies than current or previous well owners (Tables 16 and 17). Well-owning Kansans appear to be wealthier, older, better educated, and more politically conservative than their non-well owning counterparts. All of these demographics are available in the Appendix's tables.

Limitations

Social scientists prefer datasets that are generalizable and random, and I attempted to create a dataset generalizable to well owners and non-well owners in Kansas. The generalizability of these findings is limited to Kansas, but having a wide range of generalizability was not the intent of this research. Well ownership is nested within certain hydrological contexts, so gener-

alizability at a national level is not an appropriate goal when it comes to understanding water supplies and their users. The High Plains has unique groundwater supplies, regulations, and policies that limit the agency of well owners and rural citizens. This project does not unpack well owners' behaviors or offer proposals for water conservation policies—more work needs to be done to assess well owners' watering routines and aid in the development of more sustainable groundwater policies (for investigations of those topics, see Ternes 2018). Nevertheless, this work is an adequate representation of the well-owning subpopulation within Kansas and it delineates how demographics are contoured by water supplies.

Conclusion

Using a sample of 864 well owners and non-well owners in Kansas, this analysis demonstrates that well ownership is linked to higher incomes, ages, education levels, and increased levels of political conservatism. Individuals with private water wells can be framed as a distinct social group that is disproportionately burdened by drought, and well owners represent a unique community that can improve how researchers understand water supply management. Farms and communities across the world depend heavily on groundwater, and attempts to recover from large surface water deficits will include increased extractions from overdrafted aquifers (Alley and Alley 2017). Groundwater losses are a key climate change challenge, and well owners' decisions about groundwater use will have important consequences for many communities in the Anthropocene. My study of well owners in Kansas takes modest steps toward revealing how private water supplies intersect with demographics in the High Plains.

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Appendix

Table 1. Respondents organized by geographic residence and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Outside GMDs	326 (73.4%)	15 (83.3%)	65 (49.2%)	78 (33.2%)	484 (58.4%)
GMD 1	5 (1.1%)	0	2 (1.5%)	0	7 (0.8%)
GMD 2	85 (19.0%)	3 (16.7%)	31 (23.5%)	103 (43.8%)	222 (26.8%)
GMD 3	14 (3.2%)	0	17 (12.9%)	33 (13.9%)	64 (7.7%)
GMD 4	11 (2.5%)	0	9 (6.8%)	7 (3.0%)	27 (3.3%)
GMD 5	3 (0.7%)	0	8 (6.1%)	14 (6.0%)	25 (3.0%)
	444	18	132	235	829

Table 2. Respondents organized by marital status and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Married or engaged	251 (56.7%)	13 (65.0%)	114 (84.4%)	188 (80.0%)	566 (67.9%)
Widowed	15 (3.4%)	2 (10.0%)	6 (4.4%)	12 (5.1%)	35 (4.2%)
Divorced or separated	47 (10.6%)	0	5 (3.7%)	12 (5.1%)	64 (7.7%)
Single	71 (16.1%)	3 (15.0%)	7 (5.2%)	14 (6.0%)	95 (11.4%)
In a relationship, never married	16 (3.6%)	1 (5.0%)	0	7 (3.0%)	24 (2.9%)
In a relationship, previously married	41 (9.7%)	1 (5.0%)	3 (2.2%)	2 (0.9%)	49 (5.9%)
	443	20	135	235	833

Table 3. Respondents organized by race and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
White	384 (86.9%)	18 (90.0%)	125 (95.4%)	218 (95.2%)	745 (90.6%)
Hispanic	8 (1.8%)	0	2 (1.5%)	1 (0.4%)	11 (1.3%)
Black	15 (3.4%)	0	2 (1.5%)	3 (1.3%)	20 (2.4%)
American Indian	5 (1.1%)	0	1 (0.8%)	0	6 (0.7%)
Asian	10 (2.3%)	1 (5.0%)	0	2 (0.9%)	13 (1.6%)
Another race	5 (1.1%)	0	1 (0.8%)	3 (1.3%)	9 (1.1%)
Bi- or multiracial	15 (3.4%)	1 (5.0%)	0	2 (0.9%)	18 (2.2%)
	442	20	131	229	822

Table 4. Respondents organized by household income and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Under \$10,000	39 (9.0%)	3 (15.0%)	2 (1.7%)	6 (2.8%)	50 (6.4%)
\$10,000–\$19,999	53 (12.2%)	0	4 (3.3%)	7 (3.3%)	64 (8.1%)
\$20,000–\$39,999	90 (20.8%)	4 (20.0%)	9 (7.5%)	20 (9.3%)	123 (15.6%)
\$40,000–\$59,999	81 (18.7%)	3 (15.0%)	23 (19.2%)	22 (10.3%)	129 (16.4%)
\$60,000–\$79,999	62 (14.3%)	5 (25.0%)	22 (18.3%)	37 (17.3%)	126 (16.0%)
\$80,000–\$99,999	37 (8.5%)	3 (15.0%)	20 (16.7%)	30 (14.0%)	90 (11.4%)
\$100,000–149,999	42 (9.7%)	1 (5.0%)	17 (14.2%)	50 (23.4%)	110 (14.0%)
\$150,000 or more	29 (6.7%)	1 (5.0%)	23 (19.2%)	42 (19.6%)	95 (12.1%)
	433	20	120	214	787

Table 5. Respondents organized by housing type and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
One-family house, detached	330 (74.5%)	19 (95.0%)	125 (93.3%)	231 (95.8%)	703 (84.1%)
One-family house, attached	22 (5.0%)	0	2 (1.5%)	4 (1.7%)	28 (3.3%)
Apartment or duplex	74 (16.7%)	1 (5.0%)	2 (1.5%)	5 (2.1%)	82 (9.8%)
Mobile home	17 (3.8%)	0	5 (3.7%)	1 (0.4%)	23 (2.8%)
	443	20	134	239	836

Table 6. Respondents organized by residents in household and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
One	68 (15.3%)	3 (15.0%)	19 (14.1%)	30 (12.7%)	120 (14.4%)
Two	177 (39.9%)	9 (45.0%)	78 (57.8%)	143 (60.6%)	407 (48.7%)
Three	83 (18.7%)	3 (15.0%)	17 (12.6%)	18 (7.6%)	121 (14.5%)
Four	56 (12.6%)	1 (5.0%)	10 (7.4%)	21 (8.9%)	88 (10.5%)
Five	39 (8.8%)	4 (20.0%)	6 (4.4%)	16 (6.8%)	65 (7.8%)
Six or more	20 (4.7%)	0	5 (3.7%)	9 (3.4%)	34 (4.1%)
	444	20	135	236	835

Table 7. Respondents organized by home ownership and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Owned	295 (66.4%)	16 (80.0%)	130 (96.3%)	230 (96.2%)	670 (80.0%)
Rented	138 (31.1%)	4 (20.0%)	3 (2.2%)	9 (3.4%)	153 (18.3%)
Another arrangement	11 (2.5%)	0	2 (1.5%)	1 (0.4%)	14 (1.7%)
	444	20	135	238	837

Table 8. Respondents organized by political views and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Very liberal	20 (4.5%)	1 (5.3%)	0	7 (3.0%)	28 (3.4%)
Liberal	64 (14.5%)	4 (21.1%)	16 (12.2%)	24 (10.3%)	108 (13.1%)
Moderate	194 (44.1%)	6 (31.6%)	32 (24.4%)	80 (34.5%)	312 (38.0%)
Conservative	124 (28.2%)	7 (36.8%)	59 (45.0%)	97 (41.8%)	287 (34.9%)
Very conservative	38 (8.6%)	1 (5.3%)	24 (18.3%)	24 (10.3%)	87 (10.6%)
	440	19	131	232	822

Table 9. Respondents organized by sex and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Male	155 (35.4%)	9 (45.0%)	82 (61.2%)	149 (64.2%)	395 (47.8%)
Female	285 (64.8%)	11 (55.0%)	52 (38.8%)	83 (35.8%)	431 (52.2%)
	440	20	134	232	826

Table 10. Respondents organized by age and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Under 25	48 (11.3%)	2 (10.0%)	2 (1.6%)	2 (0.9%)	54 (6.8%)
25-29	44 (10.4%)	0	2 (1.6%)	9 (4.1%)	55 (6.9%)
30-34	39 (9.2%)	2 (10.0%)	3 (2.4%)	10 (4.5%)	54 (6.8%)
35-39	33 (7.7%)	0	4 (3.2%)	13 (5.9%)	50 (6.3%)
40-44	30 (7.0%)	1 (5.0%)	6 (4.8%)	9 (4.1%)	46 (5.8%)
45-49	34 (8.0%)	1 (5.0%)	9 (7.2%)	15 (6.9%)	59 (7.4%)
50-54	43 (10.1%)	4 (20.0%)	15 (12.0%)	21 (9.5%)	83 (10.5%)
55-59	45 (10.6%)	4 (20.0%)	21 (16.8%)	31 (14.0%)	101 (12.7%)
60-64	44 (10.3%)	2 (10.0%)	30 (24.0%)	45 (20.2%)	121 (15.3%)
65-69	37 (8.7%)	2 (10.0%)	19 (15.2%)	28 (12.6%)	86 (10.8%)
70-74	17 (4.0%)	1 (5.0%)	5 (4.0%)	17 (7.7%)	40 (5.0%)
75-79	7 (1.6%)	0	5 (4.0%)	10 (4.5%)	22 (2.8%)
80 and above	5 (1.2%)	1 (5.0%)	4 (3.2%)	12 (5.4%)	22 (2.8%)
	426	20	125	222	793

Table 11. Respondents organized by education level and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Less than high school	7 (1.6%)	1 (5.0%)	2 (1.5%)	9 (3.8%)	19 (2.3%)
High school graduate	92 (20.9%)	1 (5.0%)	24 (18.2%)	29 (12.4%)	147 (17.7%)
Some college, no degree	120 (27.0%)	5 (25.0%)	23 (17.4%)	47 (20.1%)	195 (23.5%)
Community college/Associate's degree	59 (13.3%)	2 (10.0%)	20 (15.2%)	23 (9.8%)	104 (12.5%)
Bachelor's degree	107 (24.0%)	7 (35.0%)	38 (28.8%)	73 (31.2%)	225 (27.1%)
Graduate degree	59 (13.3%)	4 (20.0%)	25 (18.9%)	53 (22.6%)	141 (17.0%)
	445	20	132	234	831

Table 12. Respondents organized by number of children and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
None	142 (32.2%)	5 (25.0%)	19 (14.3%)	34 (14.7%)	200 (24.2%)
One	66 (15.0%)	2 (10.0%)	14 (10.5%)	17 (7.3%)	99 (12.0%)
Two	116 (26.3%)	3 (15.0%)	32 (24.1%)	84 (36.2%)	235 (28.5%)
Three	79 (17.9%)	6 (30.0%)	44 (33.1%)	56 (24.1%)	185 (22.4%)
Four or more	38 (8.6%)	4 (20.0%)	24 (18.0%)	41 (17.7%)	107 (13.0%)
	441	20	133	232	826

Table 13. Respondents organized by number of children present in the household and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
No children present	130 (47.1%)	8 (61.5%)	77 (76.2%)	128 (70.7%)	343 (60.1)
One	58 (21.0%)	2 (15.4%)	13 (12.9%)	15 (8.3%)	88 (15.4%)
Two	53 (19.2%)	0	4 (4.0%)	21 (11.6%)	78 (13.7%)
Three	23 (8.3%)	3 (23.1%)	6 (5.9%)	11 (6.1%)	43 (7.5%)
Four or more	12 (4.3%)	0	1 (1.0%)	6 (3.3%)	19 (3.3%)
	276	13	101	181	571

Table 14. Respondents organized by description of current employment and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Working full-time, part-time, or self-employed	151 (51.7%)	9 (64.3%)	54 (68.4%)	98 (60.1%)	312 (56.9%)
Unemployed	17 (5.8%)	0	0	1 (0.6%)	18 (3.3%)
Laid off and/or looking for work	3 (1.0%)	0	2 (2.5%)	2 (1.2%)	7 (1.3%)
Retired	54 (18.5%)	3 (21.4%)	18 (22.8%)	51 (31.3%)	126 (23.0%)
In school	11 (3.8%)	0	0	0	11 (2.0%)
Keeping house	38 (13.0%)	2 (14.3%)	2 (2.5%)	4 (2.5%)	46 (8.4%)
Multiple answers	18 (6.2%)	0	3 (3.8%)	7 (4.3%)	28 (5.1%)
	292	14	79	163	548

Table 15. Respondents organized by employment in agriculture and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Yes	24 (15.2%)	4 (44.4%)	29 (59.2%)	29 (34.9%)	86 (28.8%)
No	134 (84.8%)	5 (55.6%)	20 (40.8%)	54 (65.1%)	213 (71.2%)
	158	9	49	83	299

Table 16. Respondents organized by religious beliefs and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Protestant	123 (41.3%)	4 (36.4%)	45 (50.6%)	93 (59.4%)	264 (47.7%)
Catholic	33 (11.1%)	0	26 (29.2%)	22 (14.2%)	81 (14.6%)
Latter-day Saints	2 (0.7%)	0	1 (1.1%)	0	3 (0.5%)
Jehovah's Witnesses	1 (0.3%)	0	1 (1.1%)	0	2 (0.4%)
Nonreligious, atheist, or agnostic	74 (24.8%)	4 (36.4%)	8 (9.0%)	22 (14.2%)	108 (19.5%)
Nondenominational Christian	23 (7.7%)	2 (18.2%)	0	2 (1.3%)	27 (4.9%)
Other (Jewish, Muslim, Hindu, Buddhist)	42 (14.1%)	1 (9.1%)	8 (9.0%)	17 (11.0%)	68 (12.3%)
	298	11	89	155	553

Table 17. Respondents organized by religious identity and well ownership.

	Non-well owners	Former well owners	Non-municipal well owners	Municipal well owners	Total
Born-again	51 (17.1%)	3 (27.3%)	12 (13.3%)	28 (19.2%)	94 (17.2%)
Bible-believing	44 (14.8%)	2 (18.2%)	21 (23.3%)	33 (22.6%)	100 (18.3%)
Charismatic	4 (1.3%)	0	2 (2.2%)	1 (0.7%)	7 (1.3%)
Theologically conservative	4 (1.3%)	0	4 (4.4%)	5 (3.4%)	13 (2.4%)
Evangelical	10 (3.4%)	0	3 (3.3%)	6 (4.1%)	19 (3.5%)
Fundamentalist	2 (0.7%)	0	2 (2.2%)	1 (0.7%)	5 (0.9%)
Theologically liberal	9 (3.0%)	2 (18.2%)	6 (6.7%)	5 (3.4%)	22 (4.0%)
Mainline Christian	30 (10.1%)	1 (9.1%)	11 (12.2%)	19 (12.2%)	61 (11.2%)
Pentecostal	8 (2.7%)	0	0	3 (2.1%)	11 (2.0%)
Seeker	7 (2.3%)	0	1 (1.1%)	1 (0.7%)	9 (1.7%)
Religious Right	4 (1.3%)	0	2 (2.2%)	0	6 (1.1%)
Moral Majority	5 (1.7%)	0	1 (1.1%)	3 (2.1%)	9 (1.7%)
None of these	120 (40.3%)	3 (27.3%)	25 (27.8%)	41 (28.1%)	189 (34.7%)
	298	11	90	146	545

Book Reviews

Chemical Lands: Pesticides, Aerial Spraying, and Health in North America's Grasslands since 1945.

By David D. Vail. Tuscaloosa: University of Alabama Press, 2018. ix + 180 pp. Illustrations, map, notes, bibliography, index. \$39.95 cloth.

I applaud David Vail and the University of Alabama Press for having written and published a book that dared to do anything other than demonize farming—in general—and the use of agricultural chemicals—specifically—and pretend that our country's agricultural production systems could have been created and continue to function without them. Vail's book is truly a breath of fresh air insofar as that many social scientists, social science programs, and academic presses preach increasingly partisan worldviews about large-scale conventional agricultural practices.

Farmers are, by and large, keen stewards of the land. Their livelihoods largely depend upon the health of the ecosystems within which they operate. In his book, Vail expertly explains how practices employed by “Ag pilots” evolved over many decades as they carefully considered their target landscape(s), non-target crops, and the people, animals, and surrounding environments affected by their work; they worked diligently, more often than not, alongside their clients and other stakeholders to minimize risks to these local and regional ecosystems. While many farmers were initially reluctant to adopt aerial application methods, over time, collaboration and “precision became the answer” (7).

In 1950 the convergence of federal officials, agriculturalists, aeronautical engineers, and pilots to design and build the Ag-1 “flying tractor” marked the arrival of the “first plane ever designated and built exclusively for super safe and efficient crop control flying” (88). “By considering the target landscape, non-target crops, people, and animals, and the larger environment together, Ag pilots minimized risks to local ecosys-

tems while also keeping crops safe” (128). By the 1960s a patchwork of state regulations, a growing emphasis on federal oversight of chemicals, and the release of Rachel Carson's *Silent Spring* placed Ag pilots, landowners, and weed scientists—overwhelmingly, people who were doing their dead-level best to reduce harm to the environment—on the side of what was viewed by the general public as an environmentally destructive industry.

Are there shortcomings to these practices? Absolutely. Are there alternatives? For sure, and in certain locales—largely outside the Great Plains and Midwest—nonindustrialized and nonconventional agricultural production and pest-control practices might even prove to be more logical and optimal solutions. Vail's book, however, curbs any notion that America's food production system could have been created or sustained without the help of industrialization and nonorganic—sometimes dangerous—chemicals.

Efforts that began in the mid-twentieth century aimed at improving precision in agricultural chemical application were the building blocks upon which farmers' labors continue today (e.g., Global Positioning System [GPS] technology and precision agriculture). Such efforts, many of which originated on the American Great Plains, have helped consumers get what they want out of agricultural production: to keep the cost of agricultural products as low as possible, so that we do not spend a penny more of our disposable income than necessary on the food, fuel, and fiber that our country's farmers produce. The proliferation of aerial spraying was driven not by American farmers or by “Big Ag,” but by the growing demands of American consumers. All of us.

Dr. Vail and the University of Alabama Press: this was a job well done!

Christopher R. Laingen
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The Natural History of Texas. By Brian R. Chapman and Eric G. Bolen. Foreword by Andrew Sansom. College Station: Texas A&M University Press, 2018. ix + 354 pp. Illustrations, maps, glossary, readings and references, index. \$50.00 cloth

It is an honor to review *The Natural History of Texas*. The authors are students of North American biogeographical ecology with long and distinguished careers studying vegetation, birds, and small mammals in relation to both aquatic and terrestrial habitats from Utah to North Carolina. Interestingly, this book on Texas follows, rather than precedes, their book covering North America. This sequence makes sense when one considers that Texas's boundaries capture many ecoregions found at the continental scale; thus, many generalities developed in the broader synthesis carried over as foundation to be fleshed out with insights from each author's multidecade experience as wildlife biologists across Texas.

Although I grew up in Texas and teach field ecology classes that visit at least three ecoregions, I found each chapter totally engaging, as if reported from another planet. Repeatedly, the authors noted important geological and biological details either new to me or presented from a new perspective. As wildlife biologists, the authors describe ecoregions of Texas through the lens of how diverse species populations cope with survival and reproduction in changing environments. I cannot imagine a broad overview of Texas natural history of this quality emerging from another approach.

Each chapter considers geological history and landform dynamics that generally set the boundaries of major ecoregions as well as habitat variations found therein. Superimposed on this geological mosaic is a climatic grid defined by a steep gradient of average rainfall with 10 inches lost each of 6×100 miles from Texas's eastern to western border (~60 inches to ~10 inches) and number of frost-free days increasing (~165 to ~330) from the northern to the southern border. Upon this framework the authors describe vegetation, common species, particular examples of physiological adaptations, food web relations, life history evolution, hybrid zones, and consequences of land use practices. The authors include text boxes describing great naturalists of the region, fascinating and little-known life cycles, ecological dynamics stories told by exposed fossils, and miscellaneous tales of early explorers and settlers. Descriptions of each of

12 ecoregions were organized so as to include roughly similar elements but also with appropriate variety that prevented cookie-cutter monotony. The authors are skillful in the use of imagery and metaphor to describe dynamic natural phenomena that photographs can't convey. Thus, they describe how current habitats on the geologically young Texas coast would seem to future generations ("the portraits that follow may indeed be little more than yellowed snapshots in a dusty photo album") and what follows a rare cloud burst in arid west Texas ("where the torrents flow into arroyos, walls of water race downstream, tumbling a phalanx of rocks and woody debris and scouring the vegetation").

Not surprisingly, the strength of the book is consistent with the authors' experience and expertise; small vertebrates and most but not all the ecoregions are covered. As is, the text is a well-constructed scaffold that would allow a second edition to incorporate more insect natural history and an expansion of chapter 10 on South Texas Brushland. As written, it is weighted to the subtropical tip of Texas. Expanding on the larger core of this region, which once hosted large droves of wild cattle and horses, periodically exhibits massive butterfly outbreaks, and more recently has been impacted by the root plow and by the indirect effects of white-tail deer hunting, would make it more comparable in length and scope to the very excellent chapters 8 and 9 that deal with the southern Great Plains in Texas. In future editions, too, more could be made of what early explorers encountered and the lives of indigenous groups before the Comanche dominated the region on horseback. On the other end of history, updates could be added on such dynamic topics as invasive species, fracking, and climate change.

I greatly admire this book and strongly recommend it as text or supplement for courses in field ecology, conservation biology, geography, and geology. It will appeal to environmentally conscious citizens, many of whom have arrived in Texas from other regions in recent years. It is also a must for all Texan landowners. Because Texas is about 97% privately owned, conservation of the state's diverse natural heritage is largely in the hand of private stewards. A greater appreciation for details of history and natural history that this book engenders will give all landowners, large and small, context for pride in passing along what is conserved to future generations.

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Where's There's Smoke: The Environmental Science, Public Policy, and Politics of Marijuana. Edited by Char Miller. Foreword by Jared Juffman. Lawrence: University Press of Kansas, 2018. vii + 226 pp. Illustrations, tables, index. \$29.95 cloth.

The drive toward the legalization of marijuana has unleashed a flurry of new literature concerned with its impacts and with the legal debates pertaining to permissible use. This volume, a series of 12 chapters and an afterword, authored by academic ecologists and sociologists, wildlife biologists, and wildlife managers, sheds interesting new light on the politics of legalization as well as understudied dimensions of marijuana cultivation and the illegal trespass of grow operations on federal lands.

As different authors make clear, illegal grow sites were the unintended consequence of the disastrous war on drugs, which encouraged producers to shift cultivation from Mexico to the United States. Northern California's Emerald Triangle emerged as the prime producer in this regard, a locale whose operations were soon duplicated in other parts of the Golden State and then in several others. Most grow sites go undetected.

Thousands of illegal grow sites have enormously deleterious effects on local ecosystems, including the cutting of trees, diversion of streams, and contamination of streams with sediment and fertilizers, widespread garbage, heavy use of pesticides and fungicides, and rodenticides that have exterminated many small animals and poisoned the ones that prey on them. Hikers and forestry personnel stumbling across such sites are often put in danger. These types of operations now exist in at least 22 states. As noted in chapter 1, "More than forty years of federal intransigence concerning cannabis has forced state regulators and cannabis advocates to pursue a piecemeal approach to legalization and has done very little in the way of bringing growers into regulatory compliance, and even less at protecting the environment. Debate rages as to whether legalization will enhance or depress such operations" (24).

Trespass operations are prefigured by earlier cultural geographies. Thus, in northern California the tradition

extends back to hippies in the 1960s; in Appalachia, their roots extend to the tradition of rural moonshine producers, now displaced by Mexican immigrants.

The chapters are engaging. One chapter consists of a hair-raising first-person account of a raid on an illegal grow operation. Others offer remarkably sympathetic views of the workers on grow sites. Essentially all are undocumented aliens, poorly educated, with no knowledge of the law and justice system or the risks, often lured to the work under false pretenses, who are essentially slaves. Mexican cartels may hold their families hostage to force cooperation, and such workers may not testify after being caught, fearing for the safety of their kin back home. Some are charged with all of the crimes committed by the cartel, and many are sentenced to long and harsh prison sentences.

Several chapters address legalization movements in various states. What makes this interesting is how the volume depicts different trajectories toward similar goals, paths shaped by local histories, cultures, and political environments. Medical marijuana inevitably led the way. Typically successful legalization involves multiple failed attempts. California is the behemoth of legal and illegal cultivation, producing more than all the others combined; its move toward legal recreational cannabis opened the door for others such as Colorado, Oregon, and Washington. In Washington, DC, the panopticonic gaze of congressional Republicans has repeatedly attempted to thwart legalization. The aftermath of legalization is also uneven. As chapter 9 notes, "different states have crafted different regulatory regimes and licensing requirements" (143–44). Banking services for distributors are difficult to come by, given that cannabis is still illegal at the federal level.

Taken together, these chapters provide an informative and frequently fascinating glimpse into the complex political, environmental, and regulatory dimensions of cannabis production. The book will be useful for academics, legalization advocates, and anyone interested in the world's most heavily consumed illegal drug.

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News and Notes

Conferences

Due to the COVID-19 pandemic, please check each conference's website for possible date changes or cancellations.

The 12th annual **Midwest Native Plants Conference** will be held July 17–19, 2020, at the Bergamo Center in Dayton, Ohio. Conference offers informative workshops, breakout sessions, and field trips. Website: <http://midwestnativeplants.org/>.

The **Ecological Society of America's** 105th annual meeting will be held at the Salt Palace Convention Center in Salt Lake City, Utah, August 2–7, 2020. The theme for the meeting is “Harnessing the Ecological Data Revolution.” Website: <https://www.esa.org/saltlake/>.

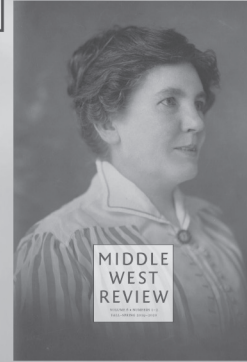
The University of Nebraska's **Center for Grassland Studies** will hold its **2020 Nebraska Grazing Conference** at the Younes Conference Center in Kearney, Nebraska, August 10–12, 2020. Website: <https://grassland.unl.edu/nebraska-grazing-conference>.

The 78th annual meeting of the **Plains Anthropological Society** will be held in Boulder, Colorado, November 4–7, 2020. Website: <http://plainsanthropologicalsociety.org/>.

Call for Essays, Reflections, and Artistic Expressions

Great Plains Research and *Great Plains Quarterly* invite essays related to the global pandemic of the coronavirus (COVID-19) to be published in future journal issues. We seek essays that discuss how this pandemic has affected the environment, the workplace, relationships, research, daily life, travel, politics, communication, the economy, and more on the Great Plains. These essays can vary in scope, voice, and length. To be considered for publication, please send your submissions to gpq@unl.edu or gpr@unl.edu at any time. For questions or more information, please contact Editorial Assistant Melissa Amateis at melissa.amateis@unl.edu.

MIDDLE WEST REVIEW



An interdisciplinary journal about the American Midwest and the only publication dedicated exclusively to the study of the Midwest as a region, *Middle West Review* provides a forum for scholars and general readers to explore the contested meanings of Midwestern identity, history, geography, society, culture, and politics to help revitalize the study of the American Midwest.

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