THESIS

COMMUNITY, INDIVIDUAL, AND REFERENDUM CHARACTERISTICS AFFECTING SUPPORT FOR CONSERVATION IN COLORADO

Submitted by

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ABSTRACT

COMMUNITY, INDIVIDUAL, AND REFERENDUM CHARACTERISTICS AFFECTING SUPPORT FOR CONSERVATION IN COLORADO

This study investigates support for conservation amongst Colorado residents. It is pertinent given both the state's limited supply of natural resources such as water and the increasing demand for other agricultural resources such as open space along the rapidly expanding urban fringes. This is also the first such study performed in the Rocky Mountains and results indicate demand for environmental goods differs when compared to other regions in the United States. The research is performed in two distinct steps. First, revealed preferences are analyzed. These come from conservation referenda data. The analysis proceeds in an analogous manner to previous studies. The Heckman two-step process is used to determine factors affecting both appearance and passage of referenda at the county and municipal level across the state. Results indicate that larger population, higher educational attainment, home-rule charter, pre-existing support, and a lower proportion of white people all increase the likelihood of a referendum appearing on the ballot. A focus on wildlife conservation in addition to open space language within the referenda, increases the likelihood of passage, relative to simply focusing on open space. An unexpected finding is that language directing funds toward open space and conservation of agricultural resources or water decreases this likelihood. Second, stated preferences are analyzed via the results of a demographically representative survey commissioned by the Colorado Department of Agriculture. Factor analysis is utilized to determine that most responses appear to be explained by three underlying factors: the value

Coloradan's place on the continued existence of agriculture in the state, a measure of views toward human's interaction with the environment, and the perceived relationship between agriculture and the environment. An ordered probit model is used to investigate how these factors, demographic variables, and survey responses affect resident's support for using public funds to help farmers conserve agricultural resources. Results indicate support for conservation decreases with age. They also suggest that those who support conservation of these resources do not appear to care about the mechanism by which they are conserved, they only care that they are conserved. Combined results from the two components of this study show younger residents with higher levels of educational attainment are more likely to support conservation. They indicate that Coloradan's stated and revealed preferences do not fully align. For instance, residents appear to support the idea of conserving water yet don't follow through in the voting booth when language including water is in a referendum. The opposite is true of wildlife conservation. Respondents appear indifferent to connecting land conservation with wildlife in their survey responses, yet referenda results suggest they are more likely to vote for such policies.

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CHAPTER 1 - INTRODUCTION

Over time, changing attitudes and perceptions have defined the conversation about conservation in the United States as it has shifted from the national stage to the local and regional level. The evolution of related policies has been both dynamic and complex. One of the key components driving the evolving environmental policy landscape, especially pertaining to conservation, is the tension between competing perspectives on ideal management. One school of thought holds that private interests are best suited to properly enact conservation measures as they are not bogged down by bureaucracy and better recognize the long-term benefits of maintaining resources to their communities. On the other side are those who believe conservation should be the result of policy nudges, incentives, and actions directed toward the usage of resources in such a way as to produce the greatest benefit to the most people.

More than a century ago, president Theodore Roosevelt, along with allies like Gifford Pinchot, the first head of the U.S. Forest Service, began implementing the doctrines of sustained yield and multiple use for public goods such as national forest and wilderness lands at the federal level[1]. This groundwork coupled with rising environmental awareness resulting from the publications of books such as Rachel Carson's *Silent Spring*, gave birth to a movement in the 1960's concerned with conservation of natural resources. In response, nationwide conservation policies such as the Wilderness Act of 1964 and the Wild and Scenic Rivers Act of 1968 were passed at the federal level[2]. The goal was to utilize publicly owned natural resources in a way

[1] Smith and Freemuth, 2007.

[2] Vig and Kraft, 2012.

that bestowed their benefits on all citizens while simultaneously conserving them for futures generations.

The result of this change in thinking was that the environmental movement which grew out of the 1960's was characterized by a strong shift in policy and public attitudes away from viewing nature in extractive terms and toward the management of public lands to benefit all citizens (Brunson and Steel, 1994). While securing national treasures, in the form of parks, wilderness, and protected lands played well on the national stage, subsequent conservation initiatives necessarily shifted focus to the regional and local levels where legal systems offered the most efficient scale for effective legislative outcomes.

Shifting the movement to the regional scale offered the potential to be considerably more adaptable at conserving resources by tapping into local interest and demand, which varied greatly based on a number of demographic, migration and other regional factors. The research presented in this thesis is focused on developing a better understanding of such conservation policy drivers in the West and, particularly, in the state of Colorado.

The goal of this study is to address the following research questions: 1) What are the community, individual, and referendum characteristics tied to support for conservation in the state of Colorado? 2) What characteristics are associated with the appearance and success of conservation referenda in Colorado? 3) What are the perceptions and attitudes of Coloradans toward conservation of agricultural natural resources such as soil, water, and open space? In order properly frame this research, it is important to understand the history of conservation in the United States and the context within which the conservation movement currently exists in Colorado.

The landscape of the conservation movement founded by Roosevelt and Pinchot evolved considerably in the decades following its shift away from the federal level. By the end of the 1980's, organizations across the West were fighting to conserve resources such as open space, working agricultural land and water on urban fringes. In response to the changing scope of the conversation about conservation, national entities like The Trust for Public Lands targeted local jurisdictions with the above amenities by helping citizens introduce conservation referenda directly onto voter's ballots. Groups like the Center for Biological Diversity fought, at the regional level, to preserve habitat for endangered species in suburban areas in the Southwest. At an even smaller scale, in places like southern Colorado, organizations such as the Palmer Land Trust worked at the local level to preserve signature landscapes, land for recreation, and working farms and landscapes in the face of rapid urban expansion.

Because resource availability and subsequent extraction and/or usage pressure differed from state to state, varying priority levels were given to different forms of conservation. For instance, population in the upper Midwest, an ideal food production region, has been migrating toward other parts of the country over the last several decades (Wozniak et al., 2011). The result is that much of the farmland in the Midwest does not face significant development pressure. Thus, demand for conservation of farmland in places like Iowa is virtually non-existent. Over that same time period, the Rocky Mountain region has experienced net in-migration, particularly in places like Colorado's Front Range (CDOLA [1], 2017), leading to much higher development

and usage pressure. Figure 1, from the American Farmland Trust, clearly shows these patterns of low and high development pressure on agricultural land at the national scale.

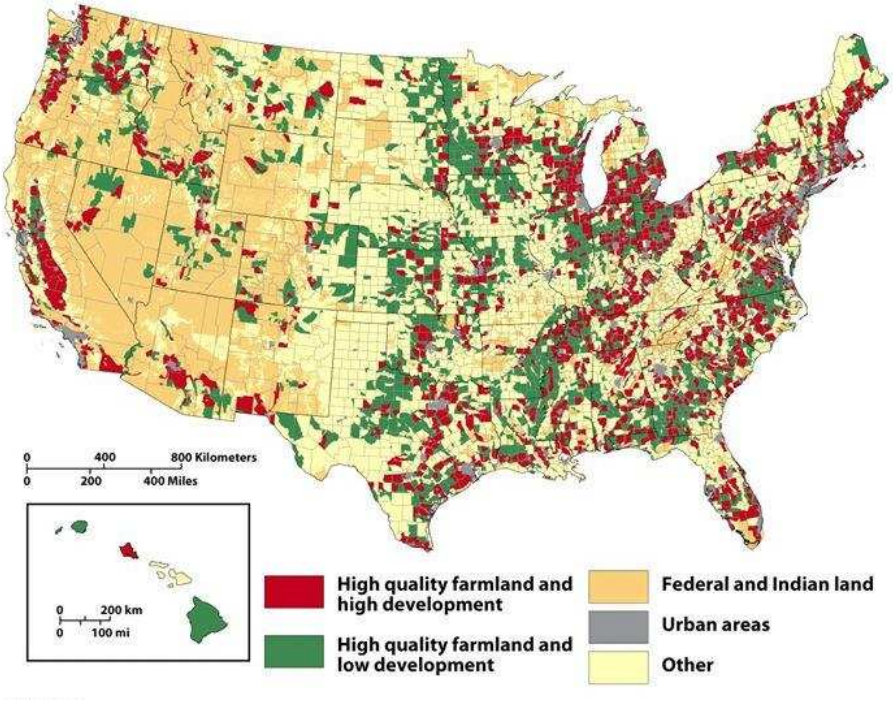

Figure 1: Farmland Development Pressure in the United States. Image provided by the American Farmland Trust.

In Colorado, the agricultural sector was a notable driver of early development and still plays a fundamental role in its economy (Graff et al., 2013). It also factors significantly into public attitudes and perceptions about the health and livability for it citizens due it location at the intersection of heritage, food security, conservation and amenity-driven quality of life. Thus, rapid development coupled with less viable agricultural land has led to conservation efforts in western states focused on farm and farmland preservation. Additionally, the West offers abundant recreational opportunities such as hiking, mountain biking and rock climbing and scenic vistas. All of these were motivating factors for state level conservation efforts in the Rocky Mountains.

Figure 2, also from the American Farmland Trust, provides a clearer picture of development pressure in the state of Colorado. This can be contrasted with Figure 3, which shows all counties in the state which passed conservation referenda between 1995 and 2005. Nearly every county on the Front Range reacted to increasing development pressure with referenda targeted at conservation of agricultural land, water and/or open space, demonstrating a clear concern for conservation in growing urban and suburban areas. Figure 3 also clearly indicates that voters in the southeastern part of the state, along the Arkansas River, are concerned with conserving natural and agricultural resources even though development pressure in their area is not high. Finally, the last thing worth mentioning in Figure 3 is the clear pattern of conservation referenda that have been brought to a vote and passed throughout all of the central Rockies, an expected spatial pattern given these areas offer the outdoor activities and amenities mentioned above.

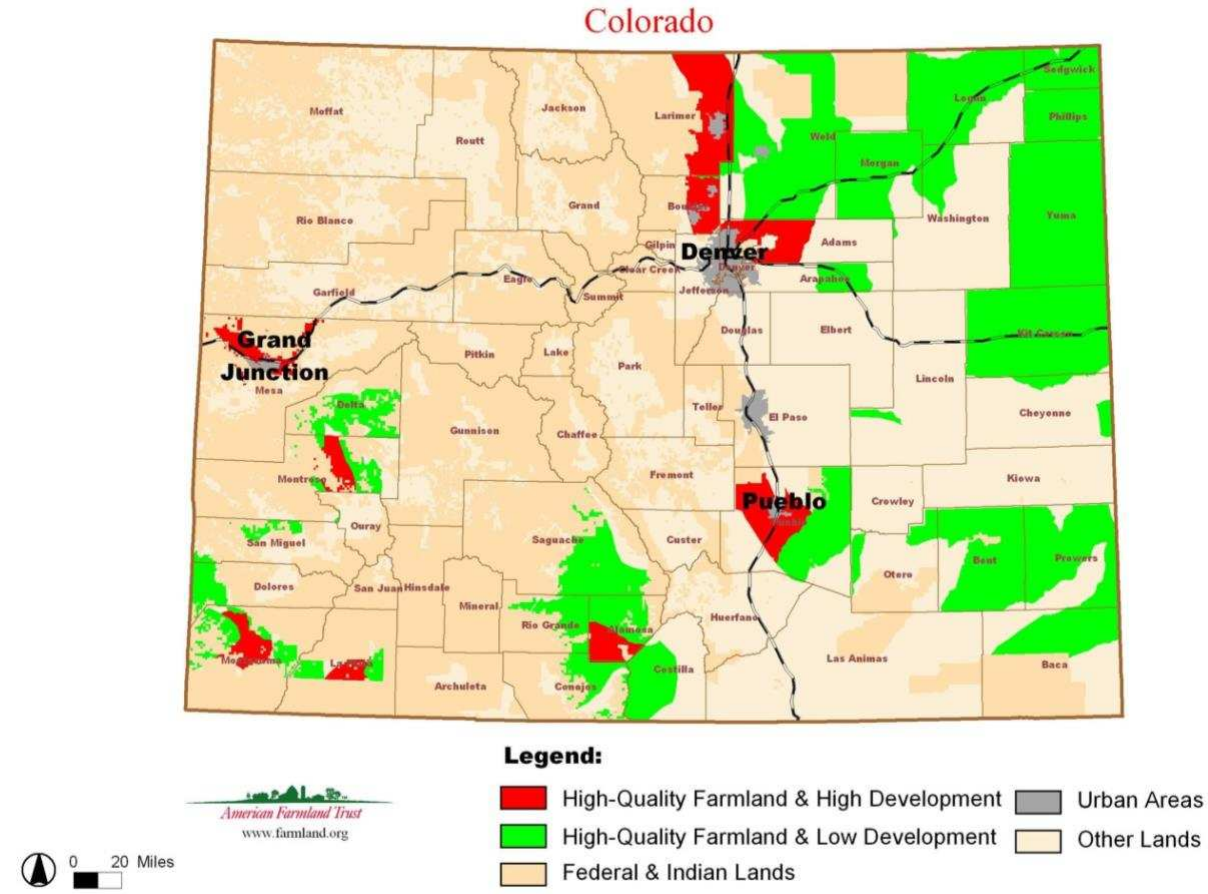

Figure 2: Farmland Development Pressure in Colorado. Image provided by the American Farmland Trust.

The fight to conserve agricultural land and water, open space, and related resources, especially in suburban areas, intensified in the late 1990's, as the growing movement attempted to enact laws enshrining their conservation goals. Private organizations also began recognizing the opportunity to utilize market-based solutions to achieve the same end. The Nature Conservancy, for instance, is one of the most effective organizations addressing conservation through these means and has protected more than a million acres of Colorado land (Nature Conservancy, 2017). Another market-based method of conservation involves the sale of development rights in the form of conservation easements. This mechanism allows landowners to receive payment from organizations like Colorado Open Lands (COL) in exchange for a legal

document agreeing the land will never be subdivided, parceled out, or further developed. Since 1993, COL has conserved more than 400,000 acres in the state of Colorado (COL, 2017).

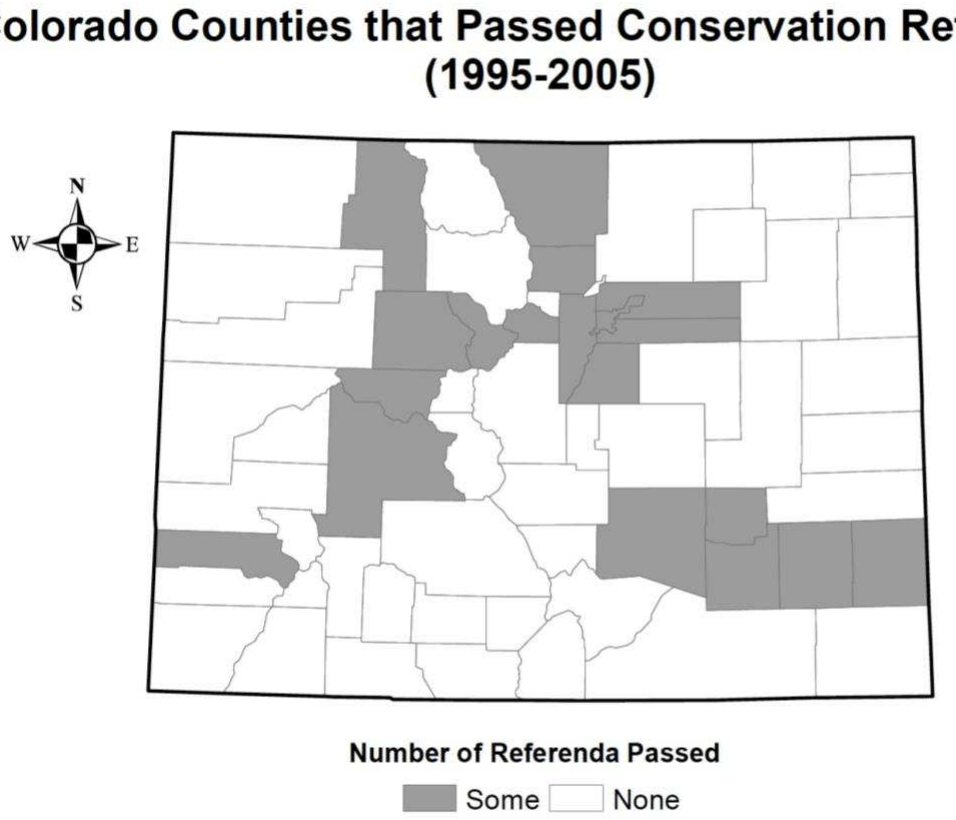

Figure 3: Colorado Counties that Passed Conservation Referenda (1995-2005). Data from the Trust for Public Lands (TPL).

In the public sphere, conservation goals are achieved by initiating and passing laws. In addition to focusing on landscapes and open space, some conservation legislation also directs funds toward protecting wildlife, water, or other specific resources. In many cases, these laws simply earmark the money for conservation, while state, county or local agencies determine what and how much of a given resource they can conserve with the budget share allocated. Because of this, it is difficult to determine how many acres of public land have been conserved via state and federal policies. What is clear, however, is that Colorado voters have allocated nearly $5 billion public dollars to the conservation effort (TPL, 2017) since 1988 via direct ballot initiatives.

While market-based solutions are undoubtedly effective, it is important to acknowledge some overlap between funding sources for money already committed to conservation by private stakeholders and the money allocated by referenda. It is also worth noting that legislative gains in public policy democratically demonstrate preferences for conservation amongst all voters, not just those advocates who can afford to donate time or money to The Nature Conservancy, Colorado Open Lands or similar organizations.

There are two possible avenues by which conservation legislation is enacted. The first is by local, state, or federal legislatures. The Endangered Species Act (ESA) is an example of this at the federal level, while California's Williamson Act provides an illustration of such legislation at the state scale. The ESA requires habitat critical to the survival of threatened species be preserved to ensure their continued existence (Layzer, 2015), while the California law allows for contracts between local land owners and governmental entities to restrict development of certain land parcels (CDC, 2016). The other mechanism for enacting these laws is direct democracy in the form of citizen motivated referenda. Laws put into practice via this mechanism tend to be both stricter and more difficult to change than their legislative counterparts (Gerber and Phillips, 2005), a boon for those supporting conservation efforts. However, this form of direct democracy is only an option in 27 of the 50 United States (NCSL, 2015). Citizens in these remaining states must rely on their elected officials to enact any form of conservation legislation.

One could argue that conservation referenda offer a much clearer picture of public opinion when compared to legislation developed and passed by a small number of policy makers at the state or federal level. As such, analysis of referenda offers the ability to define characteristics associated with voter support for conservation, in general. Such results are of value not only to organizations interested in placing conservation referenda on ballots, but also to

policy makers seeking guidance on the preferences of their constituents. Clearly understanding desires of the voting public provides the opportunity to craft conservation legislation in such a way as to maximize the likelihood of public support and, thus, passage.

Due to the state's rapid growth, agricultural heritage and natural amenities, Colorado provides an interesting case study for examining the characteristics of communities, referenda, and individuals associated with support for conservation. In part, this is due to the extremely high success rates of such referenda at the county and municipal levels. Between 1988 and 1995, only 22 conservation referenda were placed on ballots in the state. By contrast, 112 (more than five times as many) appeared before voters between 1995 and 2005 (TPL, 2017) and 73% of these passed. By comparison, at the state level only 45% of all referenda have passed since this became a legal avenue for policymaking in 1912 (CGA, 2017). The high degree of localized policy framing and support offers the opportunity to look at referenda and community characteristics across the state in order to better understand the factors associated with such a positive view of conservation.

This research explores the underlying drivers behind conservation of agricultural and natural resources at the county and municipal level in the state of Colorado. The goal is to distinguish community, individual, and referendum characteristics tied to support for conservation in the state and identify the nature of these relationships. This is approached in two distinct ways. First, demographic and policy characteristics motivating the appearance and passage of conservation referenda on county and municipal ballots are investigated. Because referenda measure exactly how voters act on their preferences, the results from this section are considered to be revealed preferences for conservation amongst Coloradans. Second, using data from a recent statewide survey, the perceptions and attitudes of residents toward conservation of

agricultural and natural resources are examined. These can be viewed as stated preferences for conservation in Colorado.

Together, these studies shed light on the actions, motivations, and factors driving Coloradan's views toward the provision of public goods such as open space. They also offer the ability to compare whether residents support what they say they are favorable towards when it comes to acting on conservation preferences. Additionally, the research presented here provides new insights into the place-based factors affecting the appearance and success of environmental referenda in the West, something which has been given little attention in previous literature. This is also the first study to compare these results with an analysis of attitudes and perceptions toward conservation of agricultural and natural resources at the state level.

In a recent statewide survey of Coloradans described and analyzed within this thesis, residents were asked their opinions about a number of issues, including conservation. One particular question focused on the transfer of development rights. This is a means of conserving agricultural land whereby farmers sell the right to subdivide their land to an entity such as a land trust. The farmer keeps the land and continues to use it, but the sale of these rights ensures the land cannot be developed. When asked whether or not they support such avenues of conservation in August of 2016, an overwhelming majority (83%) of Colorado residents stated that they did (Chriestenson et al., 2017). It is this degree of statewide support for conservation that has led to the success not only of advocacy organizations like Colorado Open Lands and Palmer Land Trust, but also to the high levels of success for conservation related ballot referenda proposed throughout the state at the county and municipal levels. Given the level of support and prevalence of data for analysis, this study is justified and motivated to investigate support for conservation in Colorado via both revealed (referenda) and stated (survey) preferences.

The first part of this research involves analysis of conservation referenda at the county and municipal level. Determining characteristics affecting appearance and passage of these referenda involves addressing two different, but potentially related, questions. The first pertains to appearance. In all counties and the majority of municipalities in the state of Colorado, a petition signed by 5% of registered voters is required in order for a referendum to appear (CRS, 2016). The characteristics associated with appearance are primarily demographic and help to define the types of communities most likely to show support for conservation referenda. The second question focuses on referenda passage. This helps to clarify ballot characteristics associated with an increased likelihood of a proposed referendum becoming law. A potential issue arises when one considers the possibility that communities holding referenda are those most likely to pass them. If this were the case, an analysis of passage would not be very useful as it would only identify the characteristics of the communities that are already more likely to support conservation, as opposed the characteristics of any given community in the state that could hold such a referendum. This is known as selection bias, a factor this study will take into account.

Several studies have investigated referenda appearance and passage (Kotchen and Powers, 2006; Nelson et al., 2007; Banzhaf et al., 2010; Heintzelman et al., 2013) and all have used a two-step modeling technique by which potential selections bias is addressed. One of the most common approaches, and the one adopted in this study, is the Heckman two-step process (Heckman, 1979). Previous studies also suggest a relatively small set of independent variables provide the model with a significant amount of explanatory power (Kahn and Matsusaka, 1997; Kline, 2006; Kotchen and Powers, 2006; Nelson et al., 2007; Banzhaf et al., 2010; Heintzelman et al., 2013). The variables chosen for the analysis presented here are primarily based on their

significance in previous literature. As expected, the model appears somewhat parsimonious, yet retains explanatory power on par with other studies on this subject.

The second part of this research investigates changing attitudes and perceptions of the public toward the highest and best use of agricultural and natural resources. Recognizing the importance of understanding attitudes toward food and agriculture in policymaking, the Colorado Department of Agriculture and Colorado State University started surveying Coloradans about these issues in 1996. The fifth such survey was performed in August of 2016 and included a representative sample of 1000 Coloradans (Chriestenson et al., 2017). One value of having a survey that is repeated every five years is that it provides a means to benchmark shifting attitudes and perceptions of Coloradans as the population changes, including those related to development rights.

The survey also asked a number of questions about conservation of agriculture and natural resources such as soil, water and open space. Additionally, respondents were queried regarding their views on using public funding to conserve these resources. Over the last 20 years, survey results indicate a sustained interest in preserving open space and agricultural resources such as soil and water on urban fringes and across the state as indicated in Figure 4. Numerous reasons exist for conserving agricultural land and water including the desire for continued production, preservation of open space, the jobs provided by working farms, recognition of agriculture's role in a community's heritage, and so on. Respondent's changing support over time is presented in Figure 5.

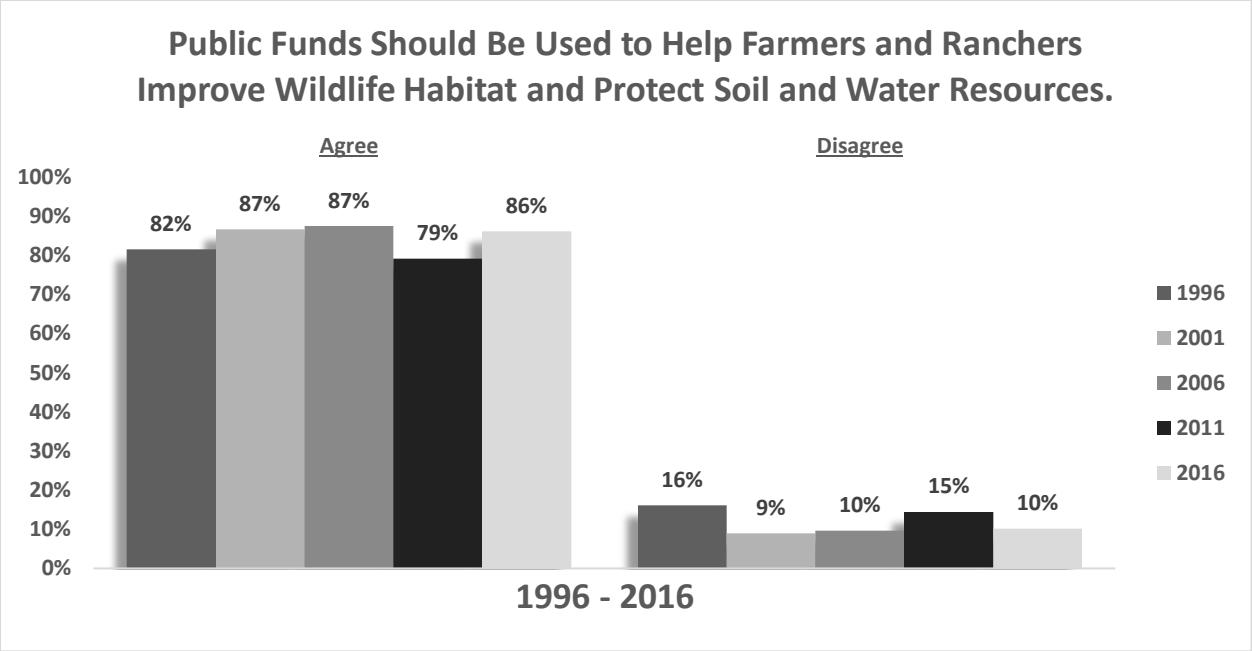

Figure 4: Colorado Public Attitudes Survey, 2017

A number of previous studies have investigated public attitudes and perceptions toward agricultural and natural resources (Brunson and Steel, 1994; Manning et al., 1998, VanLeeuwen and Skaggs, 2004; Frewer et al., 2005; Wheeler, 2005). While a dominant methodological technique does not present itself in the literature, factor analysis has been widely used as a way of identifying underlying factors responsible for explaining multiple responses (e.g., Vanleeuwen and Skaggs, 2004; Frewer et al, 2005). However, the use of factor analysis extends far beyond survey-based studies. It has also been utilized by researchers investigating cluster analysis of food customers (Thilmany et al., 2005), willingness to pay (Costanigro et al., 2011; Bond et al., 2008), linear regression analysis (Solecki et al., 2004; Shanahan, 2010), and ordered probit analysis (Cranfield and Magnusson, 2003).

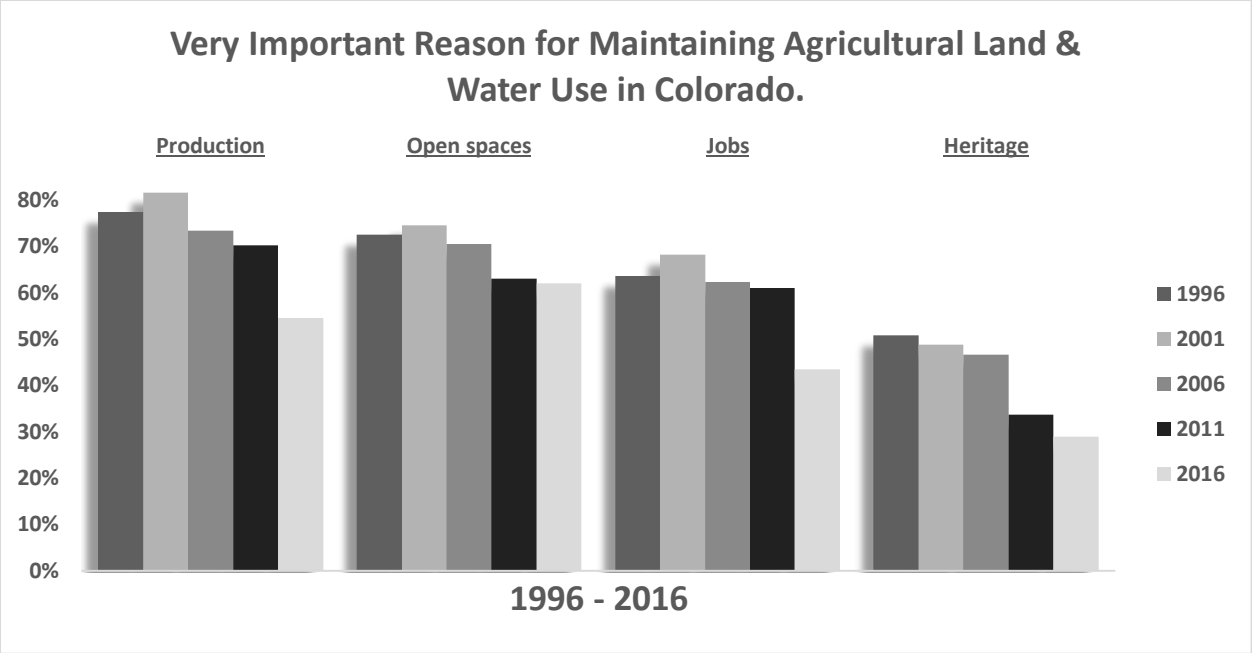

Figure 5: Colorado Public Attitudes Survey, 2017

The research into differences among respondents within these survey results first utilizes factor analysis to determine if a smaller number of underlying factors may be capable of explaining the attitudes and perceptions of Coloradans toward conservation. The second step employs an ordered probit model to characterize the influence of both the factors and variables included in the analysis on the probability of respondents supporting the use of public funds for conservation. The ordered probit was chosen as it is an ideal tool for analyzing dependent variables that are ordinal in nature (Ben-Akiva and Bierlaire, 1999; Jekanowski et al., 2000; Cranfield and Magnusson, 2003). Results from this chapter identify the characteristics of individuals that impact their likelihood of support for conservation, providing a complementary set of insights to what is learned from looking at referenda across places (community-based factors).

This study starts by analyzing community and referenda characteristics associated with successful conservation initiatives. The referenda examined cover a broad range of conservation

concerns from open space to parks to agricultural lands. The second part of this research turns the spotlight toward a specific form of conservation, namely the conservation of agricultural natural resources such as land and water. In this section, the breadth also narrows, focusing on individual characteristics associated with support for conservation. The final chapter of the thesis reviews results from the different components of the study, explores collective themes and addresses insights and implications for policy makers and interested stakeholders.

CHAPTER 2 - FACTORS INFLUENCING THE APPEARANCE AND SUCCESS OF CONSERVATION REFERENDA ON VOTERS' BALLOTS IN COLORADO

2.1 Introduction

Over the last several decades, population, population centers, and demographics have changed significantly in Colorado. The Front Range, a 140-mile region that is now home to more than 80% of the state's population[3] grew significantly between 1995 and 2005, with places like Colorado Springs, the second largest city in Colorado, posting 17% growth. These changes led to increased development pressure on agricultural lands, open space and other natural resources because of rapid development and urban sprawl. In fact, sprawl, and its impacts on air and water quality, energy consumption, and land use, has become one of the more pressing environmental issues in the broader United States in recent decades[4]. Over the last 20 years, the public has demonstrated a sustained interest in preserving open spaces and agricultural natural resources such as soil and water on these urban fringes and across the state[5], as indicated in Figure 4[6].

Between 1995 and 2005, 112 conservation referenda made it onto ballots in the state of Colorado[7], but the patterns of where these appeared and whether they were successful have not been analyzed. Changing demographics and rapid development make it imperative that policy makers have a robust understanding of 1) demographic characteristics that lead to the appearance

[3] CDOLA [2], 2017.

[4] Wilson and Chakraborty, 2013.

[5] Chriestenson et al., 2017.

[6] Chapter 1

[7] TPL, 2017.

of conservation referenda on ballots; and, 2) demographic and referenda characteristics that lead to the passage of these initiatives once they do appear. Understanding these aspects will help policy makers determine how to most effectively frame policy and utilize limited public-sector time and resources to best address their constituents' choices for public investments.

The goal of this chapter is to describe both the characteristics that increase the likelihood of a conservation referendum being placed on a ballot in Colorado and the factors that increase likelihood of passage for such a referendum. The state of Colorado requires a petition form, pre-approval, and a minimum number of signatures before an initiative can appear on any ballot (CRS, 2016). This notable effort and the resources required to get such initiatives in front of voters, coupled with the fact that more than a hundred such referenda appeared on Colorado ballots over the time period analyzed in this study, indicates voters are motivated sufficiently to act on their preferences (see Figure 4).

There are two avenues by which the results of this research can be used to help policy makers and interested parties increase the social welfare of those they serve. Only 27 states allow laws to be introduced directly by citizens through a petition process (NCSL, 2015). Policy makers in states where such direct policy pathways do not exist can utilize information about how referenda appear on ballots elsewhere to better anticipate and act upon demand for such policies from those they represent. If it is assumed that conservation of open space, soil, water and wildlife habitat does increase social welfare for some subset of citizenry, then it is clearly in the best interest of policy makers and interested parties to craft conservation policies in such a way as to maximize their likelihood of becoming law. The current chapter is intended to provide stakeholders with some of the information necessary to do this by identifying key factors affecting both the appearance and passage of conservation referenda in Colorado. One goal of

this research is to help inform the design of policies and referenda with the best possible chance of becoming law, no matter the policymaking process.

The analysis of factors influencing the initiation and passage of conservation referenda is important because they have yet to be studied in the western United States. To date, a few studies have investigated them at the national level, but most have focused on states in the Mid-Atlantic region and New England. Geographic, ecological, and numerous other characteristics defining the Rocky Mountain West are likely to differ considerably from those defining the East Coast. For instance, a much greater proportion of land is publicly owned in the West. It is not unreasonable to expect that this factor alone could alter the characteristics associated with the citizenry's interest and activity related to referenda initiation and success. Additionally, states like Colorado are destination states for in-migrating outdoor enthusiasts and recreationalists (Loudenback, 2016), leading to potentially different population characteristics and public priorities than may be found in suburban Connecticut or Delaware. Currently, the only data that policy makers and interested parties have by which to judge the potential for conservation referenda at the state, county or municipal level comes from regions east of the Rocky Mountains. The contribution of this study to the conservation literature is to either confirm patterns seen elsewhere or call into the question the blanket assumption that conservation of agricultural and natural resources is viewed uniformly by voters across the North American continent.

Lastly, the reader will note that the models utilized here appear fairly parsimonious, especially in comparison to those found elsewhere in the literature. This is intentional. Kahn and Matsusaka (1997) found ideological variables did little to increase the explanatory power of models used to explain support for environmental (rather than specifically conservation-related)

referenda in California. While Kotchen and Powers (2006), whose two-step analysis of conservation referenda closely resembles the approach taken in this paper, took this advice, others use considerably more variables. For instance, Banzhaf et al. (2010), who also adopted the two-step approach, used 38 independent variables in their selection model (pseudo-R^2 of 0.36) and 44 in their passage model (R^2 of 0.25). By contrast the model presented in this study utilizes a mere 10 explanatory variables in the selection process (pseudo-R^2 of 0.42) and 14 explanatory variables in the passage process (R^2 of 0.24). To arrive at a more parsimonious specification, the variables in this model were chosen based on their significance in previous literature informing the land conservation policy process.

The remainder of this chapter is organized into five distinct parts. The next section explores the literature on this topic. This is followed by an explanation of data used. After this, the methodology adopted for this analysis is introduced. Results are presented in the following section. Finally, the last portion of the chapter offers a discussion of the results, their usefulness, and applicability to the field and policy sector.

2.2 Relevant Literature

Using voter referenda to understand individual preferences dates back to the publication of Deacon and Shapiro's (1975) paper linking individual preferences, through the principles of microeconomic theory, to referenda results. Their study addressed the question of whether or not voting behavior related to public goods can be used to estimate public demand for those goods. The model they designed was applied to multiple California referenda and determined that voters do not alter their behavior when at the polls. Specifically, they showed that voting behavior was driven by self-interest, as are decisions pertaining to private goods. Subsequently, numerous studies have made use of a somewhat simplified version of their approach: the log-odds model

(Schroeder and Sjoquist, 1978; Filer and Kenny, 1980; Kline and Wichelns, 1994; Kahn and Matsusaka, 1997; Kotchen and Powers 2006; Nelson et al., 2007; Banzhaf et al., 2010).

The log-odds model uses, the natural logarithm of the yes votes divided by the no votes as the dependent variable. Ordinary least squares (OLS) estimates are inefficient when the dependent variables lies between zero and one and can even yield probabilities outside these bounds, which make no sense (Schroeder and Sjoquist, 1978). Hence, the log-odds transformation, which creates a continuous variable such that positive values indicate passage and negative values indicate failure. This allows for use of ordinary or weighted least squares estimation without loss of efficiency or interpretability. The log-odds model will also be utilized in this research.

A number of key papers have investigated environmental and conservation referenda results in the last two decades. Kahn & Matsusaka (1997) analyzed referenda outcomes to characterize demand for environmental goods in California. Their primary research objective was to determine whether or not demand for environmental goods could be understood using conventional economic analysis. Specifically, the authors wanted to know if it was necessary to account for ideological factors when analyzing voting behavior. They used weighted least squares (WLS) to estimate the log-odds model applied to data on statewide environmental referenda in California between 1970 and 1994. Results indicated most variability in voting patterns relating to environmental goods can be captured with traditional economic analysis. Adding variables to account for political ideology only increases the model's explanatory power by a small amount. Their results also indicate that the environment is a normal good for most individuals but becomes an inferior good at high levels of income.

A number of other studies confirm that the environment is a normal good. Nelson et al. (2007) found similar results for collectively provided open space in a nationwide analysis of open space referenda. Wu and Cutter (2011) also found this for all collectively provided environmental goods appearing on ballots in California between 1990 and 2000. Kotchen and Powers (2006) determined that publicly provided open space was solely a normal good in New Jersey and Massachusetts, and at the national level, Kline (2006) found a normal but decreasing relationship between income and likelihood of referendum appearance. Clearly, as pointed out by Waterfield (2014), the relationship between the provision of public goods and median household incomes in a given jurisdiction is neither straightforward nor simple but depends on numerous underlying factors.

Several other studies in the Northeast and Mid-Atlantic regions investigated support for conservation and open-space referenda. Kline and Wichelns (1998) found voter support for conservation of farmland and open space in Rhode Island. Duke and Aull-Hyde (2002) found Delaware residents support conservation of agricultural land as a means of continued provision of local food and to maintain agriculture as a way of life. They also found voters support conservation as a means of protecting water quality. A study of Delaware residents found that higher income levels, higher percentages of white residents, and higher urban growth rates increase the likelihood of open space policy adoption (Howell-Moroney 2004a). In the same region, both total population and median household income are found to increase the likelihood of an open-space referendum being held, whereas higher population density decreased this likelihood (Howell-Moroney 2004b). Finally, a New Jersey study by Solecki et al. (2004) found that higher socioeconomic status was associated with higher levels of support for open-space

referenda. They also found lower support in areas which already have existing open-space protection in place (suggesting diminishing marginal utility for open spaces).

Only one identified study has explored voter support for conservation initiatives in the West (the 10 contiguous states west of the 100th meridian, excluding California) and it comes from the Sociology literature. Shanahan (2010) determined that increasing population is associated with increased support for open-space referenda and higher levels of educational attainment and income are associated with decreased support for such referenda. Several key results are contrary to those found on the East Coast, in that they appear to suggest decreasing support for conservation referenda is associated with increasing levels of income and education. This seems to suggest that residents in the West, where a considerable amount of land is publicly owned, may have differing views toward conservation than their eastern counterparts. These differences provide motivation for the research presented in this chapter, one goal of which is to compare factors affecting conservation referenda success in Colorado (the West) with those identified in the Mid-Atlantic and New England states.

Kline (2006) investigated the emergence of referenda at the county level across the contiguous United States from 1999 to 2004. His primary research objective was to determine what socioeconomic factors played a role in the appearance of conservation referenda on county level ballots. Results indicate that both population density and income have a positive but decreasing effect on the likelihood of appearance. Counties with higher total population and higher educational attainment were also more likely to hold referenda. He also found that the likelihood of a conservation referenda appearing on the ballot decreased as the amount of federal land in the county increased.

The first study to research factors that affect both the appearance of conservation referenda on ballots and the likelihood of passage for those that do appear was Kotchen and Powers (2006). Their analysis was completed using the Heckman two-step process (Heckman, 1979) to account for any potential selection bias, which will be discussed later in this paper. No evidence of bias was found. The first part of their study looks at all referenda held nationwide at the local, special district, county and state levels and attempts to identify socioeconomic characteristics associated with the passage of these referenda. Following this, they investigate both appearance and passage at the state level for both Massachusetts and New Jersey.

As with nearly all such analyses, Kotchen and Powers (2006) estimated the log-odds model using WLS to determine factors pertaining to referenda success in both states and at the national level. In the state specific cases, a probit model was utilized to estimate the first-stage selection model. The national level results indicate jurisdictions with higher levels of income, higher population growth, and greater population density are more likely to pass conservation referenda. Focusing initiatives on farmland preservation increases the likelihood that a referendum will pass, contrary to the findings of Banzhaf et al. (2010) but in line with results from Heintzelman et al. (2013). At the national level, they also found that higher proportions of children in a jurisdiction decreases the likelihood of passage. At the state level, Massachusetts showed the same result regarding children. In both states, a larger proportion of senior citizens increased the likelihood of passage for open space referenda. In New Jersey, the likelihood of passage decreased if the county had already attempted and failed at passing an open space referendum. This is counter to the findings of Nelson et al. (2007) and Gill et al. (2016) who suggests that the more times a referendum is held, the more likely it is to subsequently pass.

Kotchen and Powers (2006) also determined that proposing a bond issuance as the funding mechanism increased likelihood of referendum passage. An identical result was found by Banzhaf et al. (2010). This goes against the Ricardian Equivalence Theorem which, as argued by Daly (1969), asserts that the funding mechanism for financing public goods should not matter as taxpayers will pay the entire burden regardless, either in the form of taxes or decreased asset values. In other words, voters should be indifferent between tax and bond funded referenda.

Nelson et al. (2007) addressed the same appearance and passage questions as Kotchen and Powers (2006). However, they investigated this at the municipal level only, across the entire contiguous United States, from 2000 to 2004. They compare those municipalities that held a referendum to 1000 randomly selected municipalities from across the country. Again, the Heckman two-step process was utilized and no sign of selection bias was found. A probit model was used in the first stage estimation of appearance of conservation referenda on a ballot. The second-stage model was estimated using OLS. Results indicate growth pressure increases the likelihood of a conservation referendum on the ballot. Somewhat unexpectedly, however, the growth pressure of the municipality itself does not affect the appearance of such referenda, but the growth pressure in the surrounding county does. Total population, population density, and higher levels of educational attainment increase the likelihood of a conservation referendum appearing on the ballot. Additionally, likelihood of appearance increased for municipalities that held referenda previously, though not as much if the previous referenda had passed. Factors increasing the likelihood of passage include lower population densities, higher growth pressure, and higher education levels. In contrast, higher levels of unemployment decreased this likelihood. Unlike results from studies on the East Coast, no correlation was found between

referenda with language directed toward particular amenities, such as agriculture or recreation, and the referenda's likelihood of passage.

Banzhaf et al. (2010) attempted to determine the conservation movement's effectiveness at managing direct democracy (citizen motivated referenda or initiatives) by determining factors explaining; 1) the appearance of environmental referenda on ballots, and, 2) the success of such referenda. Though they were primarily interested in the "supply" of referenda (the former question) they provide an analysis of both the selection and performance of conservation referenda from 1998 to 2006 for the entire United States at the municipal and county level. These researchers also use the Heckman two-step process. In the first stage, a polychotomous selection model is utilized to determine factors influencing the appearance of conservation referenda on ballots. In the second stage, an OLS model estimates the log-odds of passage to provide insight into factors which play a role in the success or failure of a referendum once it appears on the ballot.

Regarding the appearance of referenda, Banzhaf et al. (2010) find jurisdictions with a higher proportion of college graduates and more urban populations have an increased likelihood of holding a conservation referendum whereas those with a larger proportion of children are less likely to see such referenda on their ballots. A larger proportion of college graduates, fewer children, and bond funding are all factors that increase the likelihood of referenda passing. Results also indicate that higher population density and larger proportion of white residents decreases the likelihood of passage, as does directing the funds toward recreation or agriculture.

It is also worth noting that Banzhaf et al. (2010) found home rule charter to have a negative and statistically significant impact on the appearance of referenda at the local level. Home rule is a form of governance giving local governments the ability to choose their own laws

(so long as they do not violate state or federal statutes). Statutory law municipalities, on the other hand, simply apply state mandated laws at the local level[8]. Banzhaf et al. (2010) find that this type of local governance decreased the likelihood of land preservation referenda appearing on ballots, which contradicts the findings of Beaghan (2013). Her results indicated home rule charter increased the likelihood of appearance of such referenda.

Heintzelman et al. (2013) repeated Kotchen and Powers' (2006) analysis of New Jersey referenda, at the municipal level, but made several key changes. First, they use spatial econometrics to account for potential spatial autocorrelation. Second, they utilized a survival model to attempt to explain why some jurisdictions appear to be early adopters of conservation referenda, whereas others wait considerably longer before passing such legislation. Third, they investigate only referenda that are funded by a property tax increase. Fourth, they expand the time period analyzed to include all referenda between 1989 and 2009.

As with other studies, Heintzelman et al. (2013) used a probit model to estimate selection and an OLS model is used in the second stage. Again, selection bias was not found to be present. The appearance model is also estimated with a Bayesian probit to account for spatial autocorrelation, which is found to be present. Results from the probit, spatial and survival models do not vary greatly. Higher levels of educational attainment are associated with an increased probability of appearance. Higher population density and unemployment have the opposite effect. Results for both the OLS and spatial estimations of the passage model are presented in the paper, and while they don't vary drastically, it is clear that accounting for spatial autocorrelation decreases the significance of several variables, particularly education.

[8] According to The Brookings Institution Center on Urban and Metropolitan Policy (Richardson et al., 2003), 39 states employ statutory law (also known as Dillon's Rule) at the municipal level. However, no state completely prevents municipalities from defining some of their own laws nor does any state delegate all rule making power to it municipalities.

The results from Heintzelman et al.'s (2013) spatial autocorrelation study also indicate larger proportions of children and senior citizens increase the likelihood of passage. At both the national level and in results from the state of Massachusetts, Kotchen and Powers (2006) found that a larger proportion of children decreased likelihood of passage, contrary to the above results. However, in New Jersey, Kotchen and Powers (2006) did not find the proportion of children to play a statistically significant role in support for conservation referenda. Additionally, Heintzelman et al. (2013) found that directing funds toward farmland preservation or wildlife habitat increases the likelihood of passage, whereas directing them toward recreation decreases this likelihood.

On the topic of spatial autocorrelation, one other study worth mentioning is that of Wu and Cutter (2011). Heintzelman et al. (2013) pointed out that spatial autocorrelation is likely present in the data, and Wu and Cutter (2011) also suggest that spatial dependence is likely present at the county and local levels. However, as the results from Heintzelman et al. indicate, it is likely that spatial autocorrelation will not drastically alter model outcomes. In their analysis, it simply reduced the magnitude of the education variable. They posit that this happens due to the clustering (spatially) of underlying factors that those with higher levels of educational attainment find more attractive. Therefore, if spatial autocorrelation exists in the data analyzed in this chapter, the estimated significance of the education variable may not be as strong as this study suggests.

2.3 Data

The data for this study come from several sources. First, the Trust for Public Lands maintains a LandVote database where all land conservation referenda appearing on ballots in the United States since 1988 can be found (TPL, 2017). Referenda at the county and municipal level

in the state of Colorado between 1995 and 2005 were utilized for this study. A total of 112 were introduced during this time period, which was chosen for several reasons. First, it offered a much larger subset sample than earlier or later in the dataset. Between 1988 and 1995 only 22 referenda were introduced, as conservation had not yet become a mainstream environmental remediation strategy. Only 45 referenda were introduced between 2006 and 2016. It is not clear why this number is so small. Perhaps, the majority of the demand for conservation was sated by the glut of measures which made their way onto ballots between 1995 and 2005. Second, it was nicely centered around the 2000 Census, a source of demographic data. Finally, one goal of this study is to identify differences (if they exist) in the spatial characterization of referenda support and passage between the Rocky Mountains and the East Coast. Analysis of this time period removes as much temporal variability as possible. Had the study not covered similar time periods to the work of Kotchen and Powers (2006), Nelson et al. (2007) and Banzhaf et al. (2010), it would be less clear what comparative lessons could be drawn from the results. Of the 112 referenda held during these years, 97 were analyzed. The other 15 consisted of either referendum for which outcomes were not provided or those held in special districts. In the latter case, demographic data was not available because most of these special districts include parts of multiple municipalities and/or counties.

The vast majority (79%) of referenda analyzed mention open space (See Table 1). Likewise, the majority (73%) of these referenda passed. This indicates a clear demand for conservation of open space in Colorado. Less clear, is how the addition of other amenities such as agricultural resources, water, or wildlife affect support for these referenda. Several dummy variables were created to address these interactions. If the referenda wording included, in addition to open space, the words *wildlife*, *farm/ranch/farmland*, or *water/watershed*, the

associated dummy was assigned a one. Otherwise, it was a zero. These variables were named *wildos*, *farmos*, and *wateros*, respectively. A dummy for those referenda that did not mention open space at all was also included. The variable, *noos*, was assigned a one if the referendum didn't mention open space and a zero otherwise.

Table 1: Referenda characteristics compiled from the Trust for Public Lands conservation referendum database.

Total Observations	373	
Total Municipalities	268	71.85%
Total Counties	63	16.89%
Repeat Observations*	42	11.26%
Total Measures	97	
Repeated Measures	42	
Unique Measures	55	
Measures Passed	71	73.20%
County Measures	36	37.11%
Municipal Measures	61	62.89%
Open Space Measures mentioning:		
Farm/Ranch/Agriculture	7	9.28%
Water/Watershed	6	12.37%
Wildlife	12	13.40%
Total Open Space Measures	77	79.38%
Funding Mechanisms		
Measures Proposing a Tax	74	76.29%
Measures Proposing a Bond	23	23.71%
*Some counties and municipalities held more than one referenda during the time period studied. In these cases, the referenda characteristics differ, but the place-based ones do not.		

A dummy was also created for the funding mechanism. Other studies have analyzed differences between types of taxes. But, the most significant results in the literature tend to be between taxes and bonds, not tax mechanisms. In this case *bond* is assigned a one and any type of tax is coded as a zero. Likewise, a dummy was created to differentiate between referenda held at the county and municipal levels. *Municipal* is assigned a one and county is coded as zero. A *time trend* is also included in the model. This was done because there were so many more referenda introduced during the time period analyzed when compared to the seven previous years. If this variable turns out not to be significant, it indicates that the increase in appearance is captured by the other variables included in the analysis.

The study also addressed whether or not a latent level of support existed in many of these places, and how that might affect not only the probability of referenda appearing on the ballot, but also their chances of success. This research question is approached in two different ways. First, from the TPL referenda data, two additional variables are created to capture latent information regarding whether previous referenda activity influenced current activity. The first, *rpt*, is a dummy indicating whether or not a previous referendum had been held during the time period analyzed in this study. This variable is assigned a value of one if yes and a zero otherwise. The second, *priorpass*, is a dummy indicating whether a previous conservation referendum passed. Again, this is assigned a one if yes and a zero otherwise.

The second way latent support effects are approached involves the inclusion of a variable indicating existing support prior to the time period studied. This variable, *support*, is also formulated as a dummy whose value is one if support existed and zero otherwise. Two data sources are used to determine the presence of such support. The first is the TPL database mentioned above. If conservation referenda were held in a given jurisdiction prior to 1995, this

variable is assigned a one. However, TPL data for Colorado only goes back as far as 1988. To gauge prior support, the National Conservation Easement Database (NCED, 2017) was used. If easements were purchased in Colorado prior to 1989 by local government entities, the variable is assigned a one. Otherwise, it was zero. It is interesting to note that there were no jurisdictions that purchased conservation easements prior to 1989 that did not also hold at least one conservation referendum between 1989 and 1995 (so latent support was already captured in an existing data from TPL).

Another data source was the U.S. Census Bureau's 2000 National Census (USCB, 2013). Demographic data was retrieved at the county and municipal level both for jurisdictions that held referenda and for those that did not. Ninety-seven county or municipal level referenda held in Colorado between 1995 and 2005 were analyzed. Data was collected for all of Colorado's 63 counties and 268 municipalities. Municipalities include all incorporated cities and towns in the state (CLCS, 2013). At both levels, the same data were collected, including: *total population, proportion of population under age 18, proportion of population that is white, proportion of population with a bachelor's degree, unemployment, mean household income,* and *population density*. For the jurisdictions that held referenda, the corresponding data were assigned to each. These variables were chosen based on their reported relevance as reported in previous literature.

Three other data sources supplemented those listed above. First, the proportion of state or federally owned land in each county came from the Western Rural Development Center (WRDC, 2009). Second, the percent change in population between 1990 and 2000 was calculated from data provided by the Colorado Department of Local Affairs (CDOLA [3], 2017). The analyzed data lags the time period for which population change was calculated by 5 years to determine if the appearance of referenda is a response to population trends.

The final data included in this analysis pertains to jurisdictional government type (CDOLA [4], 2017). Colorado has two primary forms of local government. The first is general law, or statutory rule. Statutory towns and cities are limited to exercising powers specifically granted to them by state law. In these jurisdictions, a referendum must be accompanied by a petition with at least 5% of the registered voting population's signatures to be eligible for ballot inclusion (CRS, 2016). Home Rule towns and cities may adopt their own laws regarding municipal matters, including the percentage of voter signatures required for ballot petitions. There were 98 Home Rule municipalities in Colorado in 2000, and it is possible that the type of local government may play a role in whether conservation referenda appear on ballots in those jurisdictions. Thus, a dummy is included for these areas as well. Statutory towns and cities are assigned a one and Home Rule charter towns and cities are assigned a zero.

Of the 97 initiatives analyzed between 1995 and 2005, only 55 were unique. A summary of ballot data pertaining to variable choice is presented in Table 1. Twenty-two jurisdictions held more than one conservation referendum over this time period. Not surprisingly, these are located in one of two types of areas: 1) on the Front Range where development pressure is highest due to increasing population; or, 2) in prime tourist areas, such as ski resort towns, where second home development pressure is high. A summary of the number of referenda held by each jurisdiction is presented in Table 2. One characteristics worth noting is that nearly every municipality that held multiple referenda also adopted home rule charter. Considering only 99 of the 331 combined counties and municipalities are governed by home rule, this indicates the existence of a positive relationship between home rule charter and support for conservation referenda is likely.

Table 2: Characteristics of jurisdictions holding multiple referenda. With the exception of government type, which was taken from Colorado Department of Local Affairs (CDOLA [4], 2017), all data comes from the Trust for Public Lands conservation referendum database.

Jurisdiction	Number of Refernda Held	Jurisdiction Type	Government Type	Percentage Passed
Boulder County	5	County	Statutory	100%
Manitou Springs	5	Municipal	Home Rule	100%
Adams County	4	County	Statutory	50%
Boulder	4	Municipal	Home Rule	75%
Glenwood Springs	4	Municipal	Home Rule	0%
Breckenridge	3	Municipal	Home Rule	67%
Carbondale	3	Municipal	Home Rule	100%
Colorado Springs	3	Municipal	Home Rule	67%
Douglas County	3	County	Statutory	100%
Lafayette	3	Municipal	Home Rule	67%
Parker	3	Municipal	Home Rule	67%
Thornton	3	Municipal	Home Rule	67%
Clear Creek County	2	County	Statutory	100%
Golden	2	Municipal	Home Rule	50%
Greeley	2	Municipal	Home Rule	0%
Larimer County	2	County	Statutory	100%
Longmont	2	Municipal	Home Rule	50%
Routt County	2	County	Statutory	100%
Snowmass Village	2	Municipal	Home Rule	50%
Summit County	2	Municipal	Statutory	100%
Superior	2	Municipal	Statutory	100%
Erie	2	Municipal	Statutory	50%

Variables were chosen by comparing results from the primary studies pre-dating this one. They are presented in Tables 3 and 4. Based on results from the previous literature, some expected outcomes can be addressed. Variables expected to increase the probability of holding a referendum are as follows: total population (Kotchen and Powers, 2006; Nelson et al., 2007), income (Kline, 2006; Kotchen and Powers, 2006; Nelson et al., 2007; Banzhaf et al., 2010), and education (Kline, 2006; Nelson et al., 2007; Banzhaf et al., 2010). An increase in population density would be expected to decrease the likelihood of a referendum appearing on the ballot in

some cases (Nelson et al., 2007; Banzhaf et al., 2010) and increase it in others (Kline, 2006; Kotchen and Powers, 2006). Effects of the presence of home rule law on referendum support is also unclear. Beaghen (2013) found home rule to increase the likelihood of support whereas Banzhaf et al. (2010) found it to decrease this likelihood.

Table 3: Description of Variables in Selection Model

Selection Model				
Description	Mean	Std. Dev.	Min	Max
Dependent Variable	0.26	0.44	0	1
Population (1000's)	30.41	84.38	0.01	554.64
Children	0.25	0.06	0.07	0.39
White Population*	0.88	0.10	0.47	1
Education*	0.17	0.11	0	0.48
Unemployment*	0.03	0.02	0	0.13
Median Income ($1000's)	41.22	17.94	14.21	190.81
Population Density* (1000's/ sq. mi.)	1.18	1.16	0.00	8.24
Population Growth	0.37	0.36	-0.23	1.93
Law (Statutory Law = 1, Home Rule = 0)	0.66	0.47	0	1
Support (Pre-Existing = 1, Otherwise = 0)	0.16	0.36	0	1
*Variables Also Included in Passage Model				

Variables expected to positively affect the outcome of votes on such referenda include higher proportion of college graduates (Nelson et al., 2007; Banzhaf et al., 2010) and lower proportion of the population that is white (Banzhaf et al., 2010). Increasing population density should decrease the likelihood of passage (Nelson et al., 2007; Banzhaf et al., 2010), as should using a tax increase as the funding mechanism (Kotchen and Powers, 2006; Banzhaf et al., 2010) and higher unemployment rates (Nelson et al., 2007). Directly linking the language in the referendum to farm or farmland conservation sometimes increases the likelihood of passage (Kotchen and Powers, 2006) and sometimes decreases it (Nelson et al., 2007). It is also worth noting that Kotchen and Powers (2006) found that history of a prior referendum had a negative and statistically significant impact on current referendum passage. However, if the previous

referendum passed, it has a positive and statistically significant impact of nearly identical magnitude such that the two almost completely offset one another.

Table 4: Description of Variables in Passage Model

Passage Model				
Description	Mean	Std. Dev.	Min	Max
Dependent Variable	0.25	0.50	-1.16	1.44
Publicly Owned Land	0.41	0.27	0.00	0.96
Bond (Bond = 1, Tax = 0)	0.24	0.43	0	1
Jurisdiction (Municipal = 1, County = 0)	0.63	0.49	0	1
Wildlife/Open Space ("wildlife+open space" = 1)	0.12	0.33	0	1
Farm/Open Space ("farm/ranch+open space" = 1)	0.07	0.26	0	1
Water/Open Space ("water+open space" = 1)	0.06	0.24	0	1
No Open Space (open space not mentioned= 1)	0.21	0.41	0	1
Support (Prior referendum held = 1, Otherwise = 0)	0.38	0.49	0	1
Prior Passage (Prior referendum passed = 1, Otherwise = 0)	0.27	0.45	0	1
Time Trend	5.47	2.99	1	11

2.4 Methods

Using data from 331 jurisdictions in Colorado, those that held a ballot initiative were compared to those that did not to determine factors associated with the appearance of referenda on ballots. Jurisdictions included counties and municipalities. While it is not possible to observe the actual probability of a jurisdiction holding a referendum, we can observe those that did. Any jurisdiction that held a ballot initiative, regardless of its success, was assigned a one and all others were given zeros. Assuming the probability for holding a referendum in the i^{th} jurisdiction

is r_i, and assuming the error terms are normally distributed, the probability the jurisdiction puts an initiative on the ballot can be written as follows:

$$\Pr(r_i = 1) = \Phi(\beta_{0i} + \beta_1 pop_i + \beta_2 pop18_i + \beta_3 white_i + \beta_4 educ_i + \beta_5 unemp_i$$

$$+ \beta_6 hhinc_i + \beta_7 dens_i + \beta_8 change_i + \beta_8 law_i + \beta_9 support_i)$$

where $\Phi(\ )$ is the cumulative normal distribution function, *pop* is the total population of the jurisdiction, *pop18* is the proportion of the population under the age of 18, *white* is the proportion of the population that is white, *educ* is the proportion of the population with a bachelor's degree, *unemp* is the proportion of unemployed workers, *hhinc* is the median household income, *dens* is the population density, *change* is the proportion of population growth the county experienced between 1990 and 2000, and *law* indicates whether the jurisdictional government is set up as statutory rule or home rule. Finally, *support* is a dummy variable that is one if a prior level of support exists and zero otherwise. In the above form, the relationship can be estimated using a probit model. This is the first hurdle. In order to be voted upon a referendum must first show up on the ballot.

The next step is determining the factors affecting passage of an initiative once it does appear on the ballot. This is done using a log-odds model derived from the seminal work of Deacon and Shapiro (1975)

$$logodds_i = ln(\frac{P_i}{1-P_i})$$

where P_i is the proportion of yes votes on the referendum. The model takes the following form:

$$ln(\frac{P_i}{1-P_i}) = \gamma_{0i} + \gamma_1 unemp_i + \gamma_2 white_i + \gamma_3 educ_i + \gamma_4 dens_i + \gamma_5 publ_i + \gamma_6 bond_i + \gamma_7 cntmun_i +$$

$$\gamma_8 wildos_i + \gamma_9 farmos_i + \gamma_{10} wateros_i + \gamma_{11} noos_i + \gamma_{12} rpt_i + \gamma_{13} priorpass_i + \gamma_{14} T_i + \gamma_{15} Mills_i + \varepsilon_i$$

where *unemp, white*, *educ* and *dens* are demographic variables mentioned above. The variable *publ* represents the proportion of the county that is state or federally owned, *bond* is a dummy that is one if the measure was bond funded and zero if it was tax funded, *cntmun* is a dummy variable containing a one if the referendum was held at the municipal level and a zero if it was at the county level. The variables *wildos*, *farmos*, and *wateros* are dummies with a one where the ballot initiative specifically mentions open space in conjunction with wildlife habitat, farmland, or water, respectively. The variable *rpt* is a dummy that is one if a prior referendum has been held in the jurisdiction and zero otherwise. Similarly, the variable *priorpass* is one if the previously held referendum passed and zero otherwise. The variable *Mills* is the Inverse Mills Ratio (IMR) discussed below. Finally, *T* is a time trend variable. The Breusch-Pagan test for heteroscedasticity will be used to diagnose potential factor-biased variance in the independent variable's error terms. Similarly, in order to determine if multicollinearity exists, variance inflation factors (VIF's) will be calculated.

Following the lead of Nelson et al. (2007), Kotchen and Powers (2006), and Banzhaf et al. (2010), the Heckman two-step process was used linking the above probit and logodds equations and determining whether or not selection bias is present. If so, the process corrects for it in the second model. This is done by calculating the IMR from the probit model and including it as an explanatory variable in the second stage model. If the coefficient associated with this variable is statistically significant, it is an indication of bias if one were not to account for the relationship between the first and second stage models. However, its presence in the second equation allows for unbiased estimators for the other variables.

2.5 Results

Results from the two-step estimation are shown in Table 5. Because the focus of this study has to do with how the included variables affect the probability of both appearance and passage of conservation referenda, the marginal effects are presented. These effects indicate the percentage change in the probability of appearance or passage, given a unit change in a specific independent variable, assuming all other variables are held constant. The interpretation of the data is straightforward. Results suggest that jurisdictions with larger total populations, higher educational attainment, and home rule law are more likely to see a conservation referendum on the ballot. While all three of these findings are significant at the 1% level, the magnitudes vary greatly. For instance, the effect from population is barely different from zero. In the selection model, this result means that for every additional person in a municipality or county, the likelihood of a conservation referendum showing up on the ballot goes up by 0.001%. Similarly, the marginal effect associated with governance indicates that if a community switched from home rule to statutory rule, the likelihood of a conservation referendum appearing on the ballot would drop by 0.104%. By contrast, the marginal effect of education is an order of magnitude larger than that associated with governance structure. Heintzelman et al. (2013) offer a possible explanation for this. Their study indicated that accounting for spatial autocorrelation reduced the magnitude of the effect associated with education. Because most of the referenda were held on the Front Range, which has a highly educated population, it is possible that the education variable is picking up some of the potential spatial autocorrelation in the data.

Table 5: Appearance model marginal effects (Probit Estimation) and Passage model marginal effects (OLS) corrected for heteroscedasticity

	Selection Model (Probit)				**Passage Model (OLS, Robust)**			
	Pseudo-R^2	0.4199			**R^2**	0.2403		
	χ^2 (10)	179.53	***		**F(15,81)**	2.35	***	
	n	373			**n**	97		
Variable	Marg. Effect		Std. Err.	z	Marg. Effect		Std. Err.	t
pop	0.001	***	0.000	6.01	-		-	-
pop18	-0.137		0.386	-0.35	-		-	-
white	-0.422	*	0.242	-1.74	-1.756		1.607	-1.09
educ	1.141	***	0.253	4.51	1.967	*	1.084	1.82
unemp	-1.496		1.395	-1.07	-0.405		5.415	-0.07
hhinc	-0.001		0.001	-0.57	-		-	-
dens	0.001		0.016	0.08	-0.006		0.054	-0.11
change	-0.026		0.049	-0.53	-		-	-
law	-0.104	***	0.038	-2.72	-		-	-
support	0.097	**	0.047	2.06	-		-	-
publ	-		-	-	-0.144		0.332	-0.43
bond	-		-	-	0.127		0.120	1.06
cntmun	-		-	-	-0.037		0.158	-0.24
wildos	-		-	-	0.582	***	0.164	3.55
farmos	-		-	-	-0.340	**	0.153	-2.22
wateros	-		-	-	-0.621	***	0.222	-2.8
noos	-		-	-	0.152		0.151	1.01
rpt	-		-	-	0.137		0.141	0.97
priorpass	-		-	-	0.011		0.172	0.06
T	-		-	-	0.026		0.018	1.44
Mill's	-		-	-	-0.195		0.319	-0.61
*Significance Levels: * = 10%, ** = 5%, *** = 1%*								

Referenda are also more likely to appear in jurisdictions that held similar referenda prior to the time period analyzed in this study. As expected, jurisdictions with a larger proportion of white residents were less likely to hold referenda, although this finding was only statistically significant at the 5% level. There are two other points worth making in reference to this model. First, although it has the expected sign given previous studies, the number of children present in

a jurisdiction does not seem to play a significant role in whether or not conservation referenda appear on their ballot. It was expected that residents might view conservation measures as competing with education for funding, or simply may not want to pay for any additional public goods and directly spend their money on family instead. However, neither of these motives appear to be significant. Second, median household income does not play a role in appearance, which was surprising considering numerous prior studies found this relationship to be statistically significant. This likely indicates that the majority of the population values conservation of natural resources similarly, whereas elsewhere in the country it seems to be a function of increasing income and affluence. Overall, this model explained 41.99% of the variation present in the data, which is similar to estimates found in the literature, though other studies have included considerably more variables.

One factor that increases the likelihood of passage when a conservation referendum does appear on the ballot is higher levels of educational attainment. Relative to simply addressing open space, the targeting of funds toward open space and wildlife conjointly also increases the likelihood of passage. By contrast, referenda geared toward the combination of open space and water or open space and farmland were less likely to pass relative to referenda simply targeting open space. Regarding water, this result is not necessarily intuitive. However, it may be that residents view water conservation as a much larger issue and do not feel it is the job of counties and municipalities to conserve it, preferring that the state or federal government do so instead. The result pertaining to farmland is also counterintuitive, considering the scale of county open space programs and their focus on preserving agricultural lands, especially along the northern Front Range. It does make sense that both of these effects have the same sign, however, as water and agriculture go hand in hand in Colorado. This model explains 24.03% of the variation in the

data. Again, this is on par with other research found in the literature, though with far fewer explanatory variables.

To test the robustness of these results, the model was run under two additional specifications. First, the *support* variable was dropped from the selection equation and the two-step system was re-estimated. In this case, significance levels for the model and most variables changed little. However, the education variable drops below the 10% significance level under this specification. Next, *support* was added back into the selection equation and *rpt* and *priorpass* were both dropped from the passage model. This was done to see if latent, higher or lower support levels in a given jurisdiction affected the likelihood of appearance or passage. Again, under this specification, little changed except the education variable dropped below the 10% level of significance. This seems to indicate that the model and most variables are stable to specification, with the possible exception of the education variable. This instability could lend some credence to the notion that spatial autocorrelation may exist in the data and is artificially inflating the significance of education.

Though the rest of the effects were not statistically significant, there are a couple points worth noting regarding expectations and signs. First, it is interesting that the amount of state and federally owned land in a county has no bearing on the outcome of conservation referenda. Economic theory suggests this relationship should be negative. As the supply of open space in a given county increases, demand for its conservation should decrease. That does not appear to be the case in Colorado. However, this may explain why those referenda specifically targeting open space have a lower probability of passage. It is possible voters believe there is already enough open space and are more willing to vote for initiatives that specifically conserve resources they feel are in greater demand or threatened, such as wildlife. Finally, unlike results from elsewhere

in the country, neither prior appearance nor prior passage of conservation referenda has any bearing on the success of future referenda.

Another issue in need of addressing is that of selection bias. The purpose of using the two-stage Heckman process is to account for the possibility that counties more prone to passing conservation referenda were either being targeted by national conservation organizations or were the subject of large grassroots movements to get these referenda on the ballot. Given such circumstances, it would not be unreasonable to expect these jurisdictions to have different demographic or other unobserved characteristics than those that did not 'self-select' referenda onto their ballots. If this were the case, the results of the model estimating the factors affecting the likelihood of success would be biased. In other words, they would not be representative of the entire sample from which the selection model drew and, therefore, would not offer useful information.

To account for this potential bias, an IMR is estimated from the first-stage probit results. While the results themselves account for the presence of a referendum with either one (a referendum did appear on the ballot) or zero (no referendum), the IMR provides a measure for each observation that falls along a likelihood continuum, from zero to one. For all jurisdictions that did not hold a referendum, this ratio estimates how close they are to holding one. Including this new, continuous variable in the second-stage model estimation not only allows variability between selecting and non-selecting to be held constant while other effects are estimated, it also determines whether or not the bias is statistically significant. If the effect associated with the IMR is significant, then the bias is significant and vice versa. As has been the case throughout the literature, the IMR was not statistically significant in this study, indicating selection bias is not a problem.

The final two issues in need of addressing have to do with heteroscedasticity and multicollinearity in the data. Having run the second-stage model, the Breusch-Pagan test was used to ascertain whether or not variability of the log-odds was constant across the sample. The result was a χ^2 value of 2.52. In other words, the probability that the null hypothesis (constant variance) was true was 0.8876. This indicated the presence of heteroscedasticity. The model was re-estimated using the White's standard errors procedure. All estimates discussed were obtained from the heteroscedasticity-corrected model.

In order to determine the effects of the different data on the independent variable, it is assumed that each of the dependent variables are orthogonal. If two variables were highly correlated, it would not be possible to assign explanatory power to one or the other because it would not be clear which was responsible for impacting the dependent variable. This sort of correlation is referred to as multicollinearity. One method for measuring this is by calculating the variance inflation factor (VIF) (Greene, 2012). A VIF of one indicates the variable is perfectly orthogonal to all other variables. This is almost never the case, however. Thus, a general rule of thumb is that a variable retains sufficient explanatory power if the VIF is less than 10 (Marquaridt, 1970). Table 6 shows the calculated VIF's for each of the variable in the passage model. Some multicollinearity is present, but not enough to justify dropping any of the included variables. Due to the parsimonious nature of the model and the inclusion, almost exclusively, of variables which played a significant role in previous studies, this result should not be surprising.

Table 6: Variance Inflation Factors (VIF's) for Each Variable Included in the Passage Model

Variable	VIF
educ	4.24
white	3.86
priorpass	3.31
wateros	3.13
dens	3.11
rpt	2.87
farmos	2.83
cntmun	2.76
Mill's	2.58
publ	2.21
wildos	2.16
noos	1.55
unemp	1.53
T	1.42
bond	1.16

2.6 Discussion and Conclusions

This paper attempts to shed light on characteristics determining the appearance and passage of conservation referenda on ballots in the state of Colorado between 1995 and 2005. Such information is important because it adds to our understanding of conservation support. Most research to date has either been nationwide or focused solely on the East Coast, which is geographically, culturally and ecologically different from the Rocky Mountain West. Basing policy decisions on conclusions drawn too broadly or from other regions may not lead to the most effective or efficient policy processes and outcomes. For instance, residents in the West may collectively place a higher value on conservation and may have migrated to the region because of its access to natural amenities or conservation activity. In other words, many Coloradans may choose to live in communities that represent their values as demonstrated by the provision of public goods and amenities.

Previous results indicate an increase in the likelihood of both appearance and passage for higher levels of income, suggesting those who are wealthier are more likely to act on their environmental concerns. A lack of such a relationship in Colorado could imply the existence of strong environmental concern regardless of income. This could be due to in-migration by those attracted to the state's natural amenities or it could be that those who live here are simply more attached to these amenities due to their accessibility. In either case, conservation policy demand appears to be much more evenly distributed in the West than elsewhere in the country.

One shortcoming of this study is that potential spatial autocorrelation was not taken into account. It is indeed possible that such an issue exists. However, as shown by Heintzelman et al. (2013), while correlation does change the magnitude of several coefficients it did not greatly alter the significance of variables. In fact, these researchers determined that the education variable was likely 'capturing' some of the spatial autocorrelation in the model where it was not taken into account. The same is possible in this study. The magnitude of the education coefficient in both models was significantly larger than other coefficients. Still, a further exploration of the relationship across space, and how education correlates with such outcomes is justified.

A second potential shortcoming is that the data modelled is more than a decade old. The quantity of more recent referenda was not sufficient for estimating these models in a more contemporaneous timeframe. However, a multi-state estimation would likely allow for the usage of more contemporary data. On the other hand, the benefit of the time period analyzed is that it allows for a direct spatial comparison of results between the East Coast analyses and this similarly specified model of the Rocky Mountains.

There are several avenues ripe for further research in this area. First, it would be interesting to investigate changing demographics over time in the jurisdictions that have held referenda and see if it is possible to determine variable thresholds that can help predict the appearance of referenda on ballots. The 'hazard' model employed by Heintzelman et al. (2013) attempts this to some degree. Comparing these thresholds for jurisdictions across the state may lead to interesting insights for policy makers. Conceptually, if this has not already been done, it could be developed into a broader form of policy analysis that may offer the potential to significantly increase social welfare in communities across the state and country. The second avenue of further research would be to repeat this study on a larger scale. Using data from across the Rocky Mountain West would allow for more statistical power in the models and could elucidate a clearer pattern in trends, allowing researchers to explore the differences in land conservation support across different regions of the country.

The changing demographics in Colorado, and the West, do not show any signs of slowing. Interest in conservation of agricultural and natural resources such as soil, water and open space remains high. Thus, it is as important as ever for policy makers to keep the public's support for, and interest in, conservation referenda on their radars, particularly in areas experiencing rapid urban growth. This research offers an initial look at factors affecting the appearance and passage of conservation referenda on ballots across Colorado. It also motivates and opens the door to further research in this area.

CHAPTER 3 - FACTORS AFFECTING THE ATTITUDES AND PERCEPTIONS OF COLORADANS TOWARD CONSERVATION

3.1 Introduction

Agriculture was a notable driver in development of the interior western U.S. and still plays a fundamental role in its economy. Demographic patterns in these states have been changing for decades, leading to a potential shift in public attitudes and perceptions regarding land use. For instance, between 2001 and 2015, there was a 23% population increase in Denver county[9], the urban county at the heart of Colorado's Front Range, a 140-mile region that is home to more than 80% of Coloradans[10].

This population pressure creates market competition for agricultural-based natural resources such as water and land. As western states become more urban, it is important to investigate the changing attitudes and perceptions of the public toward the highest and best use of these resources. This information is of value to state and local policy makers, as well as other interested parties such as water conservation districts, developers, and non-profits, as they work to frame policies that help balance resource demand with alternative usage such as housing, extraction activity, open space and agriculture.

Recognizing the importance of changing attitudes toward agriculture in policymaking, the Colorado Department of Agriculture and Colorado State University initiated a bi-decadal series of surveys starting in 1996. The goal of the surveys is to track public attitudes and perceptions toward food and agriculture as the state's population grows. The fifth consecutive

[9] Schroeppel, 2016.

[10] CDOLA [2], 2016.

study was performed in August of 2016, with 1000 respondents selected from a representative sample of Coloradans (Chriestenson, et al., 2017).

In this chapter, data from the 2016 Colorado Public Attitudes Survey is summarized and analyzed to explore residents' views on conservation of agricultural natural resources. The analysis is divided into three parts. First, factor analysis is used to investigate relationships between respondents' support for using public funds to conserve agricultural land and water and three sets of potential explanatory characteristics. The first set represents respondent's personal relationship with agriculture. The second contains demographic information such as location, gender, age, income and length of residency. The final set includes respondent's views toward conservation and agriculture's relationship with the environment.

Specifically, the goal of factor analysis is to determine underlying factors that help to explain respondent's views towards conserving agricultural and natural resources that are common across variables, allowing for a reduction in the total number of explanatory variables in the ordered probit model used in the second part of this analysis. The purpose of this second step is to investigate the impacts of both the underlying factors and explanatory variables on resident's support for conservation. Finally, the third component is a robustness check. The ordered probit analysis is repeated under four different variable specifications including a varying set of factors and variables to determine whether results and model significance are stable and not overly sensitive to specification. The goal of this multi-stage process is to gain the most complete yet succinct view of factors affecting Coloradan's attitudes and perceptions toward the use of public funds for conserving agricultural natural resources. Results of the ordered probit identify the relationships between residents' views on conservation and the factors that significantly affect those views.

Coloradans support the conservation of agricultural natural resources for numerous reasons. For instance, close proximity to open space has been shown to increase property values (Irwin, 2002). Many citizens want to see land remain in production while others value the open space it provides. Support also exists because of employment provided by the agricultural sector. Likewise, agriculture's deep relationship with heritage and community development in the West is a motivating factor for many residents. Figure 6 captures the changes in support for conservation of agricultural resources over time in Colorado for the reasons listed above.

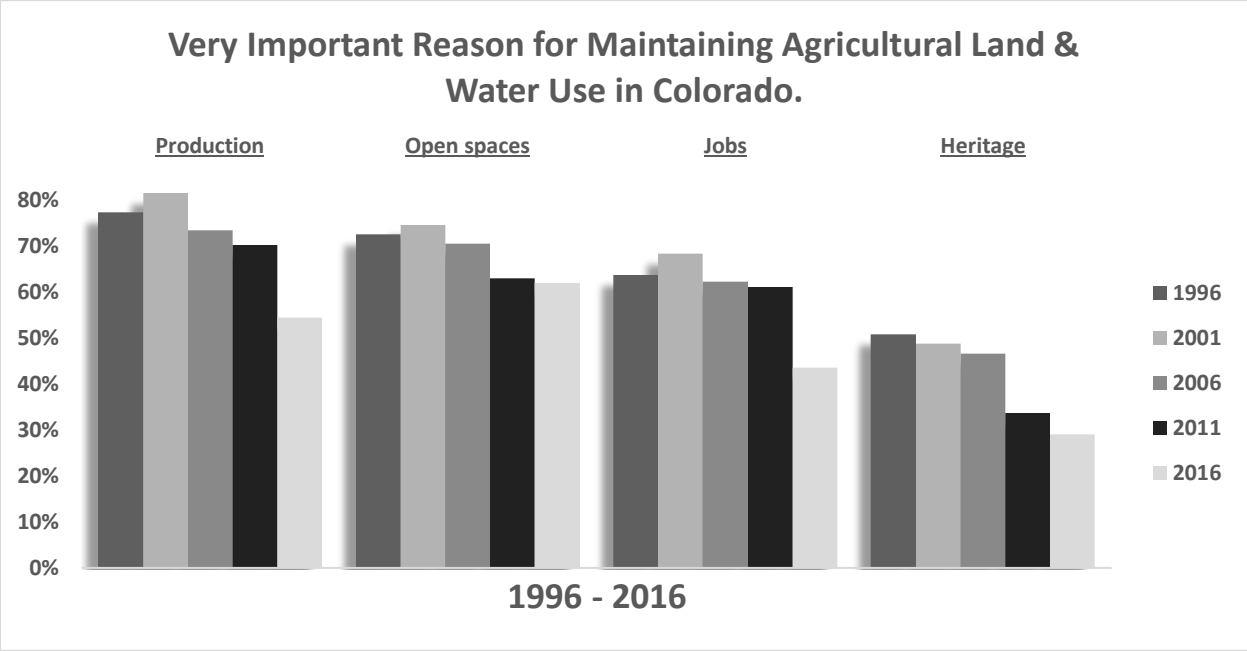

Figure 6: Colorado Public Attitudes Survey, 2017

Due, at least in part, to its broad appeal, as captured in Figure 6, policy makers are also interested in the conservation of agricultural resources. Clearly, Coloradans support conservation, however their motivations are varied. Thus, the challenge lies in identifying the common language and agenda necessary to earn support from the largest possible share of stakeholders. Hence, the motivation for this study, the focus of which is to investigate the characteristics of people who support such conservation in order for policy makers to better

understand their constituents and their needs. It is possible for policy makers to proactively avoid potential conflicts when armed with the right information from the outset.

The demographic, societal and attitudinal factors driving interest and support in agricultural land conservation deserves deeper exploration for several reasons. First, if there is a relationship between demographic characteristics and support or opposition to conservation, it could imply certain types of conservation policies may be better suited to specific communities or places. Likewise, these relationships can inform policy makers as to where such policies stand little chance of passing and, therefore, may not be worth the effort. Second, if views toward conservation are robust across all respondents and different types of questions it could indicate general support for other conservation and/ or environmental measures as well. Alternatively, it might mean common answers among subgroups of the population are being driven by certain underlying ideological factors.

This chapter is organized as follows: first, the relevant literature is summarized and the methodology is laid out; next, there is a thorough explanation of the specific data utilized coupled with expected outcomes and analysis; following this is a discussion of the results; and, finally, the value of this study to policy makers is explored.

3.2 Literature Review and Methods

The goal of this chapter is to investigate the relationship between Coloradans' views toward conservation of agricultural natural resources and 1) their direct relationship with agriculture, 2) their demographic characteristics and 3) the context in which these views exist. This is done in three distinct steps. Initially, the set of variables analyzed in this study is broken into two groups. The first consists of the two variables over which the respondent has little control, *age* and *gender*. These are set aside and used in the second and third parts of the analysis

only. The second group of variables consists of those over which the respondent has some control (*relate*, *resid*, *loc* and *income*). Answers to survey questions, over which respondents were able to exercise full control, make up the third group (*econ*, *imp*, *devel*, *os*, *resp*, *permits*, *conserve*, *water*, *wildlife*, and *quality*). These last two sets of variables are analyzed using factor analysis. The next step utilizes an ordered probit model. Finally, the third step involves estimating the ordered probit model under several variable specifications to draw inferences about the relationship between a variety of factors and stated support for agricultural resource conservation, and to assess overall stability of the results.

The multivariate statistical techniques of factor analysis and principal component analysis (PCA) have been applied both collectively (Costanigro et al., 2011) and individually (Bond et al., 2008; Skaggs and VanLeeuwen, 2004) as a means of eliminating multicollinearity amongst explanatory variables prior to further analysis. PCA is a form of factor analysis and varies little from its counterpart. In a study attempting to determine market segments for various beef products, Thilmany et al. (2005) used factor analysis to analyze survey data from Colorado consumers as a means of determining how different explanatory variables were related prior to including such factors in further analysis which attempted to identify different market segments and how those segments could be targeted with marketing messages. Bond et al. (2008) performed a similar investigation using a national consumer survey in which they hoped to identify the characteristics underlying consumer's WTP for various attributes of fresh produce. As with Thilmany et al., in using cluster analysis to identify market segments, the underlying themes resulting from factor analysis were substituted in place of the variables for which they were key drivers. This reduced the total number of explanatory variables with little loss of information.

In similar research to what is presented in this chapter, Cranfield and Magnusson (2003) used factor analysis to analyze attitudinal responses to survey results. They determined all such feedback could actually be captured by replacing the five original question responses with two underlying factors which appeared to explain the feedback. This paper is discussed in further detail later. Skaggs and VanLeeuwen (2004) analyzed feedback from a statewide survey of New Mexico residents regarding attitudes toward the environment, agriculture and government. Using factor analysis, they identified three "attitudinal indicators": factors on which they found consistent, heavy loading. Finally, Manning et al. (1998) explored the relationship between environmental values and attitudes toward national forest management using a survey of Vermont residents. They analyzed 42 survey responses regarding environmental ethics. Their study indicated Vermont residents grouped environmental beliefs and attitudes into ten underlying categories, generally confirming the results of previous studies performed on the topic.

In a paper analyzing the spatial character of a statewide open-space referendum in New Jersey, Solecki et al. (2004) used PCA to remove multicollinearity amongst variables. The resulting factors were then incorporated into their OLS regression as independent variables. Likewise, Shanahan (2010) used PCA to identify characteristics associated with support for land conservation initiatives in the West. Her goal was to determine whether the referenda offered support for or against the New West-Old West dichotomy proposed in the sociology literature. The three factors on which loading was heaviest replaced the variables they were found to help explain and accompanied several other explanatory variables in further analysis of the research questions using weighted least squares (WLS). Frewer et al. (2005) used PCA in a slightly different way. The purpose of their research was to identify factors affecting attitudes and

perceptions of Dutch consumers toward animal friendly husbandry systems employed by farmers. In developing their final survey questions, they distributed a larger sample survey and used PCA on the feedback to reduce the number of final survey questions. This allowed them to ask fewer total questions while still acquiring the same desired information.

Factor analysis and PCA are closely related multivariate statistical methods, as indicated both by the mathematical structure of the decomposition (Abdi & Williams, 2010) and the results of Costanigro et al.'s (2011) use of both techniques in estimating WTP for 'local' versus 'organic' attributes. Usage of both processes could be considered redundant. This paper utilizes only factor analysis because it is a more robust technique and it is the opinion of the author, after visual inspection of both sets of results, that PCA offers little or no additional information of value. As with the studies mentioned above, the goal during this step of the research is to identify underlying factors that help to explain the variability in multiple independent variables. Doing so allows these factors to replace the larger set of independent variables they help to explain, reducing the total number of variables present in the econometric model employed in the second part of this study. Additionally, it allows for a more integrated explanation of the attitudes and perceptions driving Coloradan's support for conservation, rather than piecemeal feedback to a variety of individual issues presented in the survey.

The goal is to determine whether there are underlying factors affecting responses to more than one question. This is done by grouping variables that are highly correlated and have little or no correlation with other variables (Abdi and Williams, 2000). Each grouping is considered a factor and explains a certain amount of variance in the survey data. A measure of explained variance (eigenvalue) greater than one indicates the underlying factor is significant. Eigenvalues of less than one indicate background noise (Abdi and Williams, 2000).

As factor analysis seeks to explain the amount of variance in the data with the same number of factors as explanatory variables, it is important to recognize that if one or more factors significantly (or fully) drive variance among multiple explanatory variables, then later factors may compensate with negative eigenvalues. In other words, they are going to explain negative variance because the statistical process has run out of variables to analyze. This may lead to confusing results but can be dealt with by rotating the data. One of the most common means of doing this is called the Varimax method (Manning, 1999; Abdi and Williams, 2000; VanLeeuwen and Skaggs, 2004; Shanahan, 2010; Costanigro et al., 2011). This process rotates the data in such a way that the most important factor explains the maximum possible variance in the data. Each additional factor is then calculated relative to its new relationship with the data. The technique stops calculating factors when the explanation of variance reaches zero.

Once the data is rotated in such a way that the optimal set of explanatory, orthogonal factors has been found, the correlation between each factor and each variable is calculated, as is the proportion of variance in the data captured by each factor. The former measure is referred to as the 'factor load' and indicates the degree to which the underlying factor explains the variance in a given variable. Following Costanigro et al. (2011), factor loads greater than 0.4 will be considered significant. The latter measure is called the 'proportion'. It is important to keep in mind that the sum of the proportion of data variance explained by all underlying factors is equal to one only if all underlying factors are completely orthogonal. However, if there is correlation between the factors, the sum of explained variance will be greater than one, as multiple factors will be explaining the same variance in the cases of such correlation. It is likely that any underlying factors discovered in this study will not be completely orthogonal. Therefore, it will not be surprising if the amount of variance explained by the combined factors is greater than one.

The most ideal econometric models explain the greatest amount of variance with the fewest explanatory variables. Given that this study utilizes survey data, the range of possible independent variables is limited. However, it is possible that, amongst those analyzed, there is a smaller number of underlying characteristics that jointly explain the variability in feedback across a series of survey variables. If this is the case, then the number of explanatory variables can be decreased by including the reduced number of underlying factors in the econometric model in place of the variables they explain. In summary, the desired outcome of the first step in this analysis is to determine if any such factors exist and, if so, which variables they can replace in further analysis.

A common method of measuring variation in survey feedback is the use of a discrete choice model such as an ordered probit. Utilization of ordinary least squares (OLS) for estimating public attitudes and perceptions is neither appropriate nor recommended, as feedback is often measured on an ordinal scale, meant to measure strength of belief or opinion. Attempting such a linear regression would lead to inefficient estimations as well as the potential for estimated likelihoods that are below zero or exceed one (Jekanowski et al., 2000).

Probability models, such as the probit, are ideal estimation approaches to situations where the dependent variable is binary. However, as is often the case with public attitude surveys, the dependent variable may contain several ordinal categories based on level of agreement or strength of support. In this case, the ordered probit is the best possible estimation model (Wheeler, 2005). By assuming consecutive levels of the explanatory variable to be mutually exclusive, consecutive shares of a continuous normal distribution, the ordered probit model captures the correlation among all alternatives within a given choice set (Ben-Akiva and Bierlaire, 1999). Specifically, this type of model allows for the precise calculation of the

predicted probability (the area under the normal curve) of each category being analyzed, as well as the associated marginal effects.

Given the nature of ordered probit models, it is clear why they are often the tool of choice for analyzing survey responses. Their application in such cases is broad. In a study, similar in many respects to the one performed in this paper, Jekanowski et al. (2000) attempted to identify demographic and attitudinal factors associated with an increased probability of purchasing local food products in the state of Indiana. A statewide survey was analyzed using an ordered probit model and it was determined that consumers had a strong preference for Indiana products.

Cranfield and Magnussen (2003) used factor analysis to reduce multicollinearity amongst potential explanatory variables in survey data from a random sampling of several large cities in Canada. The new, smaller set of data was analyzed with an ordered probit model to estimate consumer willingness-to-pay (WTP) amongst Canadian residents for certified pesticide free produce. In a study of Australian agricultural professionals, Wheeler (2005) analyzed characteristics that played a key role in shaping the attitudes of agricultural professionals toward organic agriculture and biotechnology. Utilizing data from a large survey, she estimated an ordered probit model and determined that increasing topical knowledge led to higher support for organic agriculture and decreased support for the usage of genetically engineered technology in agriculture.

In a forestry study conducted in Alabama, Zhang et al. (2007) used an ordered probit to examine public attitudes toward funding urban forestry programs. Respondents stated that trees played a positive role in many aspects of their lives and they felt trees should be cared for properly. However, the results of this study indicated that there was not broad support for the

funding of urban forestry programs that would both provide and care for trees in cities throughout the state.

Given the literature on the topic, the nature of the survey data involved in this analysis and the overall applicability of ordered probit models, this analysis technique will be employed. In such models, the dependent variable is neither continuous nor binary, but is an ordinal ranking. While it is not possible to know the exact probability of a given observation, it is possible to know the category the observation falls into as defined by the ordinal variable. In other words, given three possible categories of a dependent variable *y*, an ordered probit can be written as,

$$\Pr(y = 1) = \Phi(-\beta'X)$$

$$\Pr(y = 2) = \Phi(\Omega - \beta'X) - \Phi(-\beta'X)$$

$$\Pr(y = 3) = 1 - \Phi(\Omega - \beta'X)$$

Here, $\Phi(\ )$ is the cumulative normal distribution, Ω is width under the normal distribution of category 2 (called *Omega* in the results), β is a vector of coefficients to be estimated, and X is a vector of explanatory variables. In constructing the current model, the explanatory variables consist of *age* and *gender*, any factors with an eigenvalue greater than one and any additional variables not driven by these factors. The coefficients estimated by this process are of limited use due to the challenge of interpretation, aside from determination of statistical significance. Their sign indicates which direction an increase in the value of the independent variable shifts the dependent variable and their magnitude is indicative of overall importance as an explanatory variable. From these estimates, the likelihood a given observation falls into any particular category can be calculated, as can the marginal effects.

As is typical for a limited dependent model, the marginal effects explain the response of the dependent variable to changes in a given independent variable. However, the interpretation depends on the nature of the independent variable being analyzed. If it is continuous, the interpretation is given as the response, in terms of probability of the dependent variable to a unit change in the independent variable. However, if the explanatory variable is ordinal, the response is explained as the change in probability, of the dependent variable, given a one level increase in the independent variable's ordinal ranking.

The goal of this investigation is to explain the characteristics driving Coloradan's perceptions and attitudes toward usage of public funds for conservation of agricultural and natural resources. The results will identify which variables play a statistically significant role in affecting this support. They will also tell how changing them affects levels of support.

3.3 Data

In August of 2016, the Colorado Department of Agriculture and Colorado State University partnered with TNS (www.tns-us.com) to survey a representative sample of Colorado residents. This survey replicates studies conducted in 1996, 2001, 2006 and 2011 by the Colorado Department of Agriculture partnering with different cohorts of CSU personnel and Departments over the years. In 1996, the Colorado Department of Agriculture and Ag Insights worked with Colorado State University's Human Dimensions in Natural Resources Unit to develop the first survey of Colorado residents to determine the public's attitudes towards such issues as food prices, food safety, pesticide use, environmental practices, wildlife and agriculture, animal welfare, land use, population growth and agricultural land preservation, among other things. Subsequent reports have compared the attitudes of Coloradans towards the

above-mentioned issues. Several of these survey questions are pertinent to the research presented here.

Table 7 presents a summary and description of the variables used in this analysis along with a more detailed explanation of each variable. The variables *Factor1*, *Factor2*, and *Factor3* are the results of factor analysis. As such, they will not be addressed here, but inferences one could make about these endogenously derived factors are shared in the results section. The variables can be broadly organized into three groups: 1) those which define the sample and over which the respondent is able to exercise little control (*age* and *gender*), 2) those over which the respondent has partial control (*relate*, *resid*, *inc*, and *locate*), and 3) those over which the respondent has control (*prim*, *econ*, *imp*, *devel*, *os*, *resp*, *permits*, *conserve*, *water*, and *quality*). The final group includes responses to all survey questions analyzed. Variables in the first two groups are demographic with the exception of *relate*, which indicates whether the respondents currently live, or have ever lived, on a farm or ranch. (Responses to this question over time are presented in Figure 7.) The importance of these categories will become clear in the next section when factor analysis is used to identify underlying drivers.

Table 7: Summary Statistics and Description of Variables Used in this Analysis

	Survey Question	Mean	Std. Dev.	Min	Max	Type
prim	Public funds should be used to help farmers and ranchers improve wildlife habitat and protect soil and water resources. (dependent variable) 1) Agree. 2) Neutral. 3) Disagree.	0.50	0.67	0	2	Ord.
relate	Have you lived/ do you live on a farm? 1) Yes. 2) No.	0.74	0.44	0	1	Bin.
age	What is your age?	48.35	16.78	18	87	Cont.
resid	How many years have you lived in Colorado? 1) Fewer than 5. 2) 6-10 Years. 3) 11-15 Years. 4) 16-20 Years. 5) More than 20 Years.	2.37	1.33	0	4	Ord.
gender	Enter your gender. 1) Male. 2) Female.	0.53	0.50	0	1	Bin.
inc	What is your household's annual / yearly income before tax? 1) Under $20,000. 2) $20,000-$40,000. 3) $40,000-$50,000. 4) $50,000-$75,000. 5) $75,000-$100,000. 6) $100,000-$125,000. 7) $125,000-$150,000. 8) Above $150,000	3.41	2.04	0	7	Ord.
locate	What is the condensed RUC code for the county the respondent lives in? 1) Metro. 2) Metro Adjacent. 3) Rural	0.13	0.48	0	2	Ord.
econ	Among Colorado's economic sectors, would you rank agriculture as one of the top two in terms of importance for the long-term future of Colorado? 1) Yes. 2) No.	0.56	0.50	0	1	Bin.
imp	In Colorado, considerable agricultural land and water is being converted to non-agricultural uses such as houses, roads and other uses. How important do you think it is to maintain land and water in agricultural production? 1) Very Important. 2) Somewhat Important. 3) Not Very Important. 4) Not at All Important.	0.40	0.56	0	3	Ord.

devel	Agricultural lands are being converted to non-agricultural uses. We would like to know your thoughts about one way of preventing this. It is possible to use public funds to buy the development rights from farmers and ranchers willing to sell them. The farmer or rancher would still own the land and be able to use it for agriculture, but the land couldn't be developed for housing or industrial purposes. How much do you agree or disagree with this approach for maintaining ag land? 1) Strongly Agree. 2) Moderately Agree. 3) Slightly Agree. 4) Slightly Disagree. 5) Moderately Disagree. 6) Strongly Disagree.	1.29	1.21	0	5	Ord.
os	An increasing number of Colorado cities and counties have open space programs. Such programs typically acquire natural areas and trail corridors and allow public access. Some programs use part of their money to help protect local farms or ranches as well. How much do you agree or disagree that more local open space programs should use part of their money to help minimize the loss of farms and ranches? 1) Strongly Agree. 2) Moderately Agree. 3) Somewhat Agree. 4) Slightly Disagree. 5) Moderately Disagree. 6) Strongly Disagree.	1.15	1.10	0	5	Ord.
resp	How responsible do you believe agriculture in Colorado has been in protecting the environment? 1) Almost Always Responsible. 2) Usually Responsible. 3) Sometimes Responsible. 4) Almost Never Responsible	1.27	0.69	0	3	Ord.
permits	Ranchers with permits to graze on public land treat that land appropriately. 1) Strongly Agree. 2) Moderately Agree. 3) Slightly Agree. 4) Moderately Disagree. 5) Strongly Disagree.	1.26	1.05	0	4	Ord.

conserve	Current agricultural practices in Colorado to conserve water and soil are effective. 1) Strongly Agree. 2) Moderately Agree. 3) Slightly Agree. 4) Moderately Disagree. 5) Strongly Disagree.	1.66	0.92	0	4	Ord.
water	Water for economic development is often transferred from agriculture. Providing water to agriculture can mean constraints on other uses of water. If it were a dry year, should agriculture receive top priority for water usage? 1) Yes. 2) No.	0.30	0.46	0	1	Bin.
wildlife	Water for economic development is often transferred from agriculture. Providing water to agriculture can mean constraints on other uses of water. If it were a dry year, should wildlife and in-stream flows receive top priority for water usage? 1) Yes. 2) No.	0.82	0.38	0	1	Bin.
quality	How important is the presence of ranches, farms, and agriculture to the quality of life in Colorado? 1) Very Important. 2) Moderately Important. 3) Slightly Important. 4) Not Important.	1.48	0.67	1	4	Ord.
Factor1	Replaces variables imp, devel, os, and quality In Model 2, Model 3, and Model 4	0.00	0.82	-1.25	3.32	Cont.
Factor2	Replaces variables water, and wildlife in Model 3 and Model 4	0.00	0.85	-0.62	1.81	Cont.
Factor 3	Replaces variables resp, permits, and conserve in Model 4	0.00	0.72	-1.97	2.54	Cont.

The dependent variable, *prim*, is listed first. For ease of interpretation, this response has been modified. Initially, it was stated as follows: "How do you feel about the following statement? Public funds should be used to help farmers and ranchers improve wildlife habitat and protect soil and water resources." Respondents were given a Likert scale with options ranging from "Strongly agree" to "Strongly disagree" with "Slightly agree" in the middle. Responses to

this question over time are presented in Figure 8. In order to simplify the results, these five categories were collapsed into three. The first category includes those who either strongly or moderately agreed. The second category includes those who slightly agreed. This category is treated as if it is a neutral response since no neutral option was given and it is both the middle category and the least polarizing option. The final category includes those who either moderately or strongly disagreed.

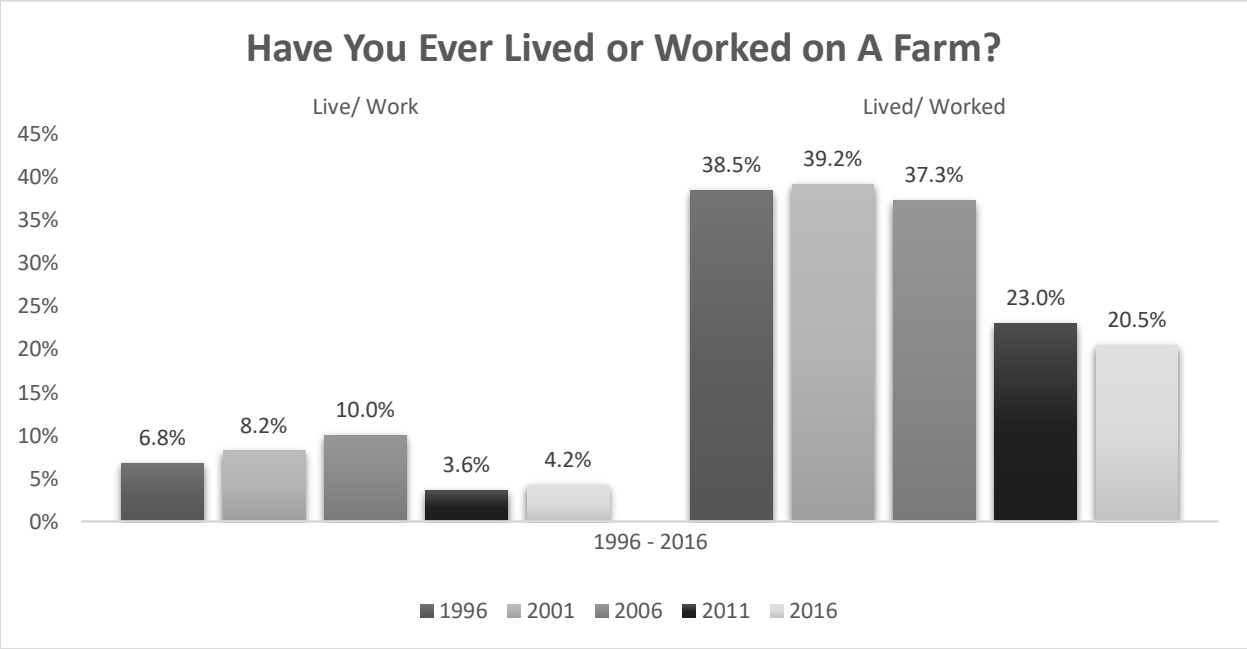

*Figure 7: Explanatory variable, **relate** (Colorado Public Attitudes Survey, 2017)*

These three categories can be thought of as follows. Category 1 contains those who support use of public funds by farmers to conserve agricultural and natural resources such as soil, water, open space, etc. Category 2 contains those who are indifferent. Finally, category 3 consists of those who oppose the use of public funds by farmers for such purposes. At this point, it is important to recognize that some who fall into category 3 may still support the idea of conservation but believe public funds should not be used to achieve such ends. For the purposes

of this study, it is assumed that these supportive, yet fiscally conservative respondents make up an insignificant proportion of this category.

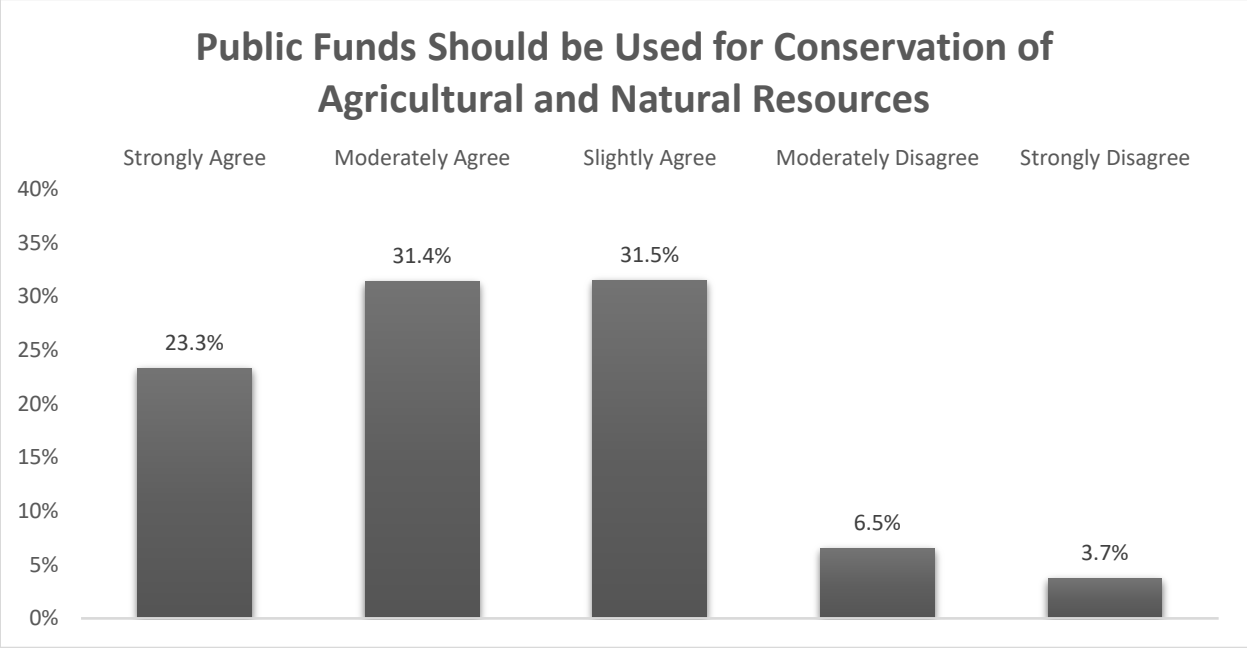

Figure 8: Dependent variable, ***prim*** *- Support for Conservation Amongst Coloradans. These five categories were collapsed into three for analysis. The two columns on the left were combined and re-labeled as 'Agree'. The middle column was re-labeled as 'Neutral' and the two columns on the right were combined and labeled as 'Disagree'.*

The variables, *age*, *gender*, *relate*, *resid*, and *inc* are responses to questions asked at the beginning of the survey in order to ensure the sample of Coloradans participating were demographically representative of the state as a whole. When it comes to conservation and environmental issues, studies have shown that support increases as income increase (Nelson, 2007; Kotchen and Powers, 2006; Kline, 2006; Kahn and Matsusaka, 1997; Wu and Cutter, 2011). Women have been shown to be more supportive of environmental organizations and causes than men (Heintzelman, 2013; List, 2004; Mohai, 1992). Thus, it is reasonable to expect a positive relationship between *gender* and *inc*, individually, and the dependent variable. It is not clear what to expect of the variables *resid*. The only research to investigate *age* (Kotchen and Powers, 2006), found mixed results.

As explained in Table 7, the above variables should be self-explanatory. The variable *locate*, however, requires further elucidation. Respondents were asked for their zip code, to ensure they were Colorado residents. Given this information, the county in which each respondent resides was identified. Using the rural-urban continuum (RUC) codes, it is possible to determine if each county is in one of three broadly defined classifications based on urban influence: metro, metro-adjacent, or rural. The United States Department of Agriculture's Economic Research Service (USDA-ERS, 2016) developed the RUC location classification. Identifiers fall along a continuum from code 1, which is metro (counties with more than a million residents) to code 9 which is rural (counties with a population of less than 2500 that are not adjacent to urban areas). Codes 1-3 are considered metro, codes 4,6, and 8 each have smaller populations, but are adjacent to metro areas and codes 5,7, and 9 have small populations and are not adjacent to metro areas. For the purpose of this study, each of these three subgroups was recoded to a single number. Codes 1-3 were coded to 1 and represent all metro counties. Codes 4,6, and 8 were coded as 2 and represent all metro adjacent counties. And, codes 5,7, and 9 were coded to 3 and represent all rural counties. This set of data is ordinal and allows for coherent interpretation of how or if a respondent's context relative to urban (vs. rural) places may affect their views toward conservation.

The remaining variables are all responses to survey questions pertaining to the importance of agriculture, natural resources and perceptions of the relationship between agriculture and the environment in the state of Colorado. While Table 7 gives a basic summary of the questions asked, a bit of further explanation is necessary for each variable, as some are taken, in full, from the survey while others represent only partial survey responses.

The binary variables, *econ*, *water*, and *wildlife*, are partial survey responses. In the case of the former, respondents were asked to rank economic sectors in order of their perceived importance to the state of Colorado. The sectors amongst which they had to choose were education and public service, mining and petroleum, high tech industries, tourism and recreation, and agriculture. For this analysis, responses indicating agriculture as one of the two most important sectors are assigned a one and all others receive a zero. Figure 9 shows how the 'most important' category has changed in the eyes of Coloradans over time. Regarding expectations, it seems likely that those who view agriculture as an important sector to the state's economy will also favor the conservation of land and water to support agriculture. In other words, a positive relationship is expected between *econ* and views on conservation of agricultural resources.

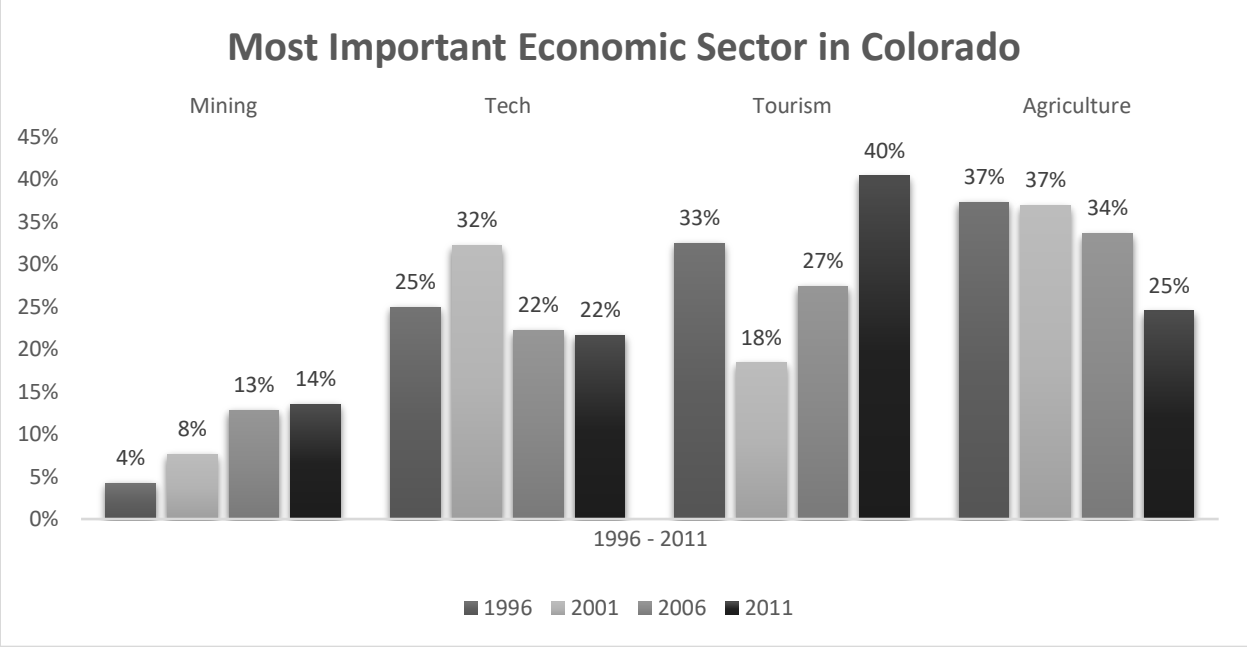

Figure 9: Explanatory variable, ***econ*** *(Colorado Public Attitudes Survey, 2017)*

The variables *water* and *wildlife* are analogous to *econ*. Both are derived from the same question, which asked how respondents would rank water usage priorities in a dry year. They were given four options from which to choose: lawns and landscaping, rafting and fishing,

agriculture, and in-stream flow levels for wildlife. For the variable *water*, any response indicating agriculture as the top priority is assigned a one and all others are given a zero. For the variable *wildlife*, any response indicating agriculture as the top priority is assigned a one and all others are given a zero. Figure 10 shows how respondent's views on the top priority for water usage in a dry year have changed over time. As with *econ* it seems reasonable to expect a positive relationship between the responses to *water* and views on conservation. It is also plausible to expect those who prefer water be devoted to wildlife in a dry year may not be interested in using public funds to conserve agricultural resources.

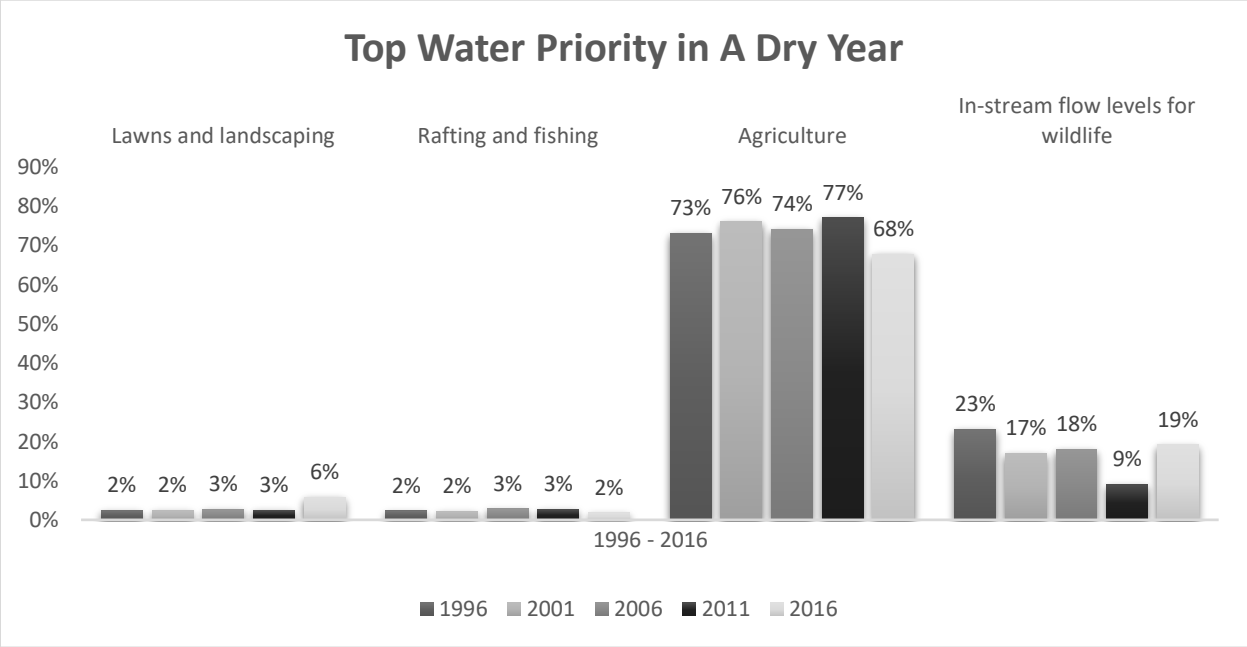

Figure 10: Explanatory variable, ***water*** *(Colorado Public Attitudes Survey, 2017)*

The remainder of the variables are worded, verbatim, in Table 7. The variables *imp* and *quality* measure how important respondents perceive agriculture to be to the state. These are included to determine if there is a relationship between respondent's beliefs about agriculture's importance and their desire to conserve agricultural natural resources. Figures 11 and 12, respectively, show how these responses have changed over time. As these questions deal with the

fundamental importance respondents place on agriculture in the state of Colorado, it seems reasonable to expect a positive relationship between each of them and the dependent variable.

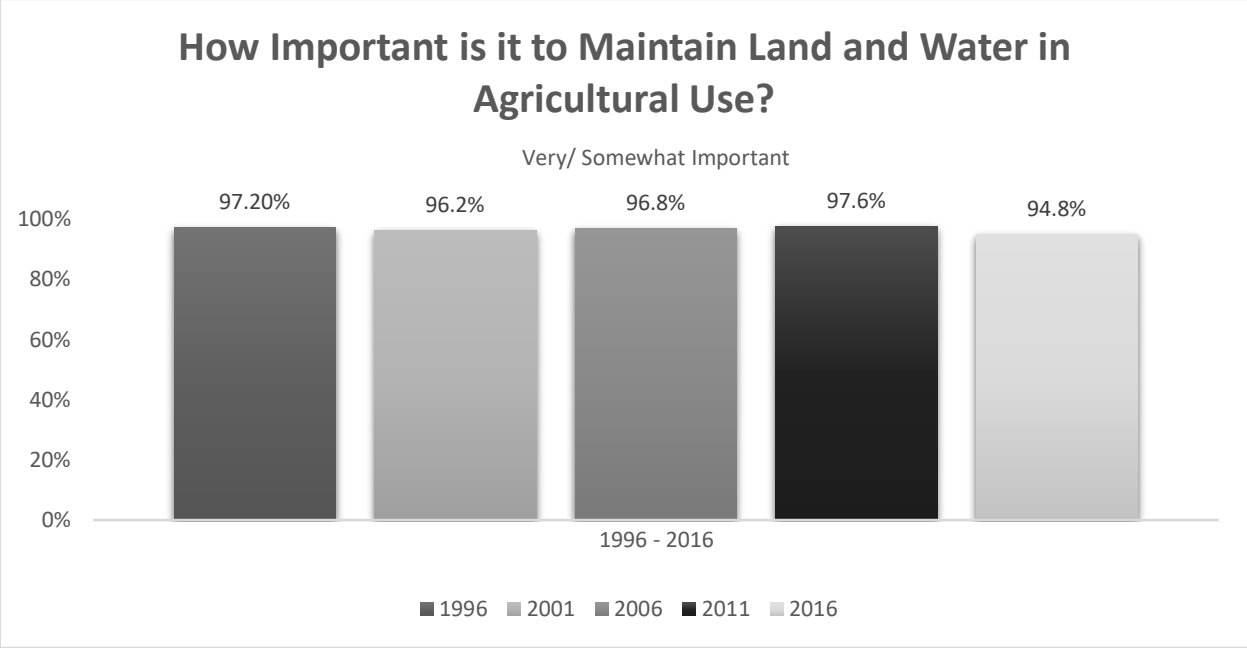

*Figure 11: Explanatory variable, **imp** (Colorado Public Attitudes Survey, 2017)*

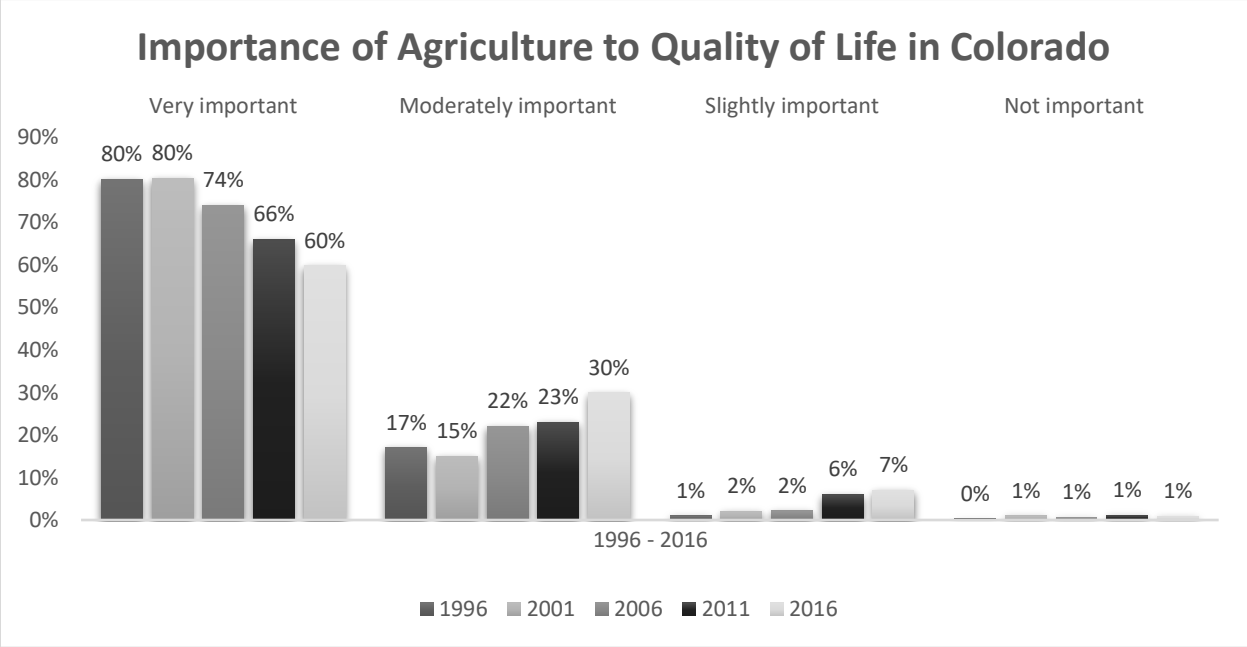

*Figure 12: Explanatory variable, **quality** (Colorado Public Attitudes Survey, 2017)*

The variables *devel* and *os* measure the degree to which respondents view specific publicly funded mechanisms (the purchase of development rights and usage of open space programs, respectively) as palatable means of conservation. The inclusion of these variables is intended to determine if a relationship exists between respondent's views toward conservation and how they would like to see that conservation take place. Figures 13 and 14, respectively, show responses to these questions over time. Because these questions also ask about using public funds to conserve agricultural resources, they test whether respondents have preferences for the mechanism by which agricultural resources are conserved. As such, it is difficult to develop specific expectations for these variables. If respondents view all mechanisms as equal, a positive relationship would be expected. However, it they would rather see public funds put to specific conservation uses (open space program purchasing farmland or development rights) then the relationship could be negative.

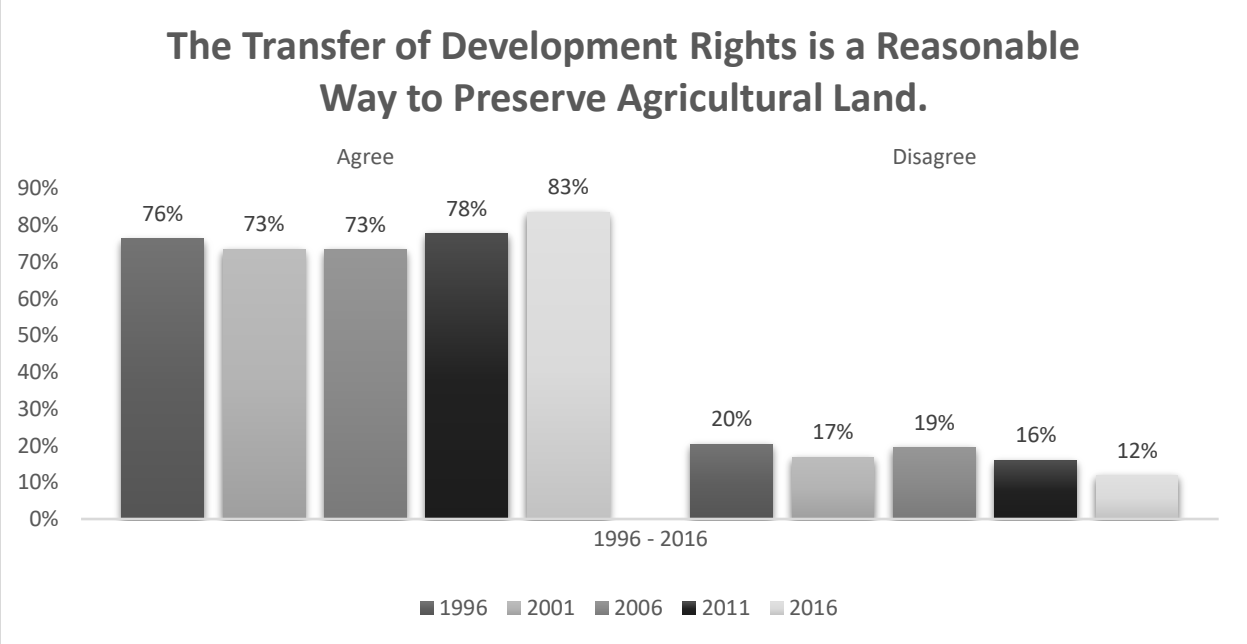

Figure 13: Explanatory variable, ***devel*** *(Colorado Public Attitudes Survey, 2017)*

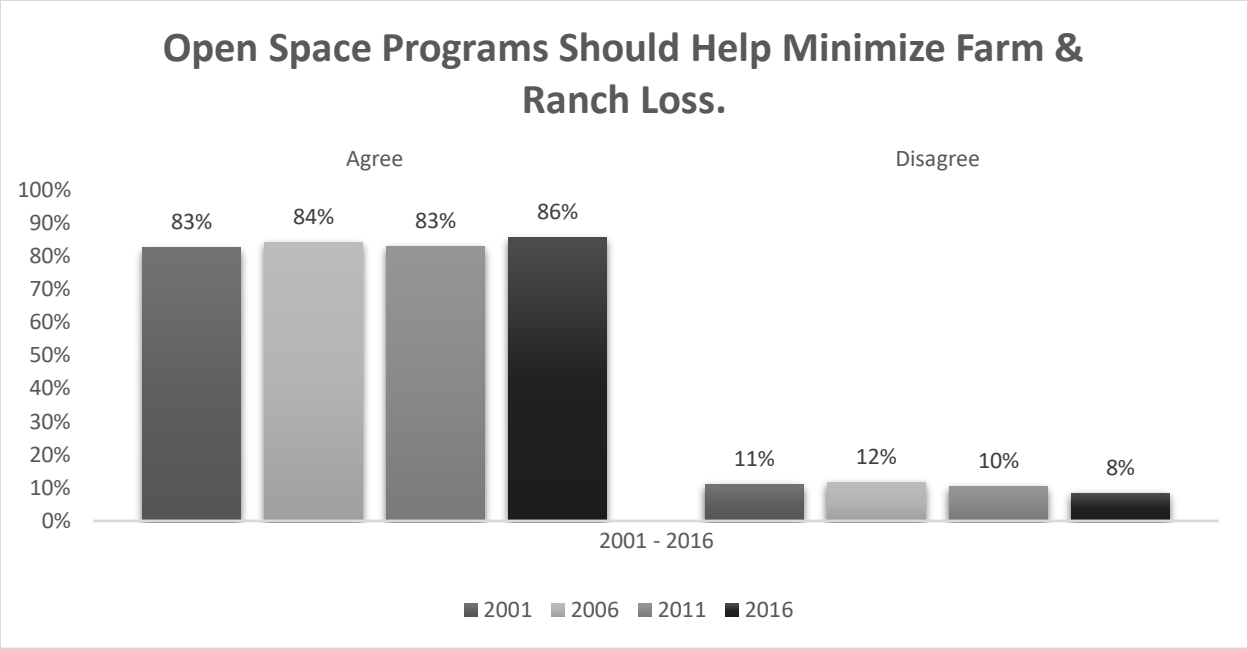

Figure 14: Explanatory variable, ***os*** *(Colorado Public Attitudes Survey, 2017)*

The final three variables are *resp*, *permits*, and *conserve*. The first asks, broadly, about the interaction between farmers and ranchers and the environment. The second asks, specifically, about how ranchers treat public lands. The third asks about the success of agriculture in conserving basic resources (soil and water). Collectively, these questions measure how respondents perceive the relationship between Colorado agriculture and the environment. As before, it is difficult to develop a priori expectations. For instance, it could be those who believe agriculture has a good relationship with the environment see the use of public funds by farmers to conserve agricultural resources as an effective means to an end. Alternatively, respondents may view some tension with respect to agriculture's relationship with the environment if they believe farmers and ranchers do not have an incentive to conserve resources. In the former case, the relationship between these independent variables and support for conservation would be expected to be positive. In the latter case, the relationship would be negative. Figures 15, 16, and 17, respectively, present responses to these questions over time.

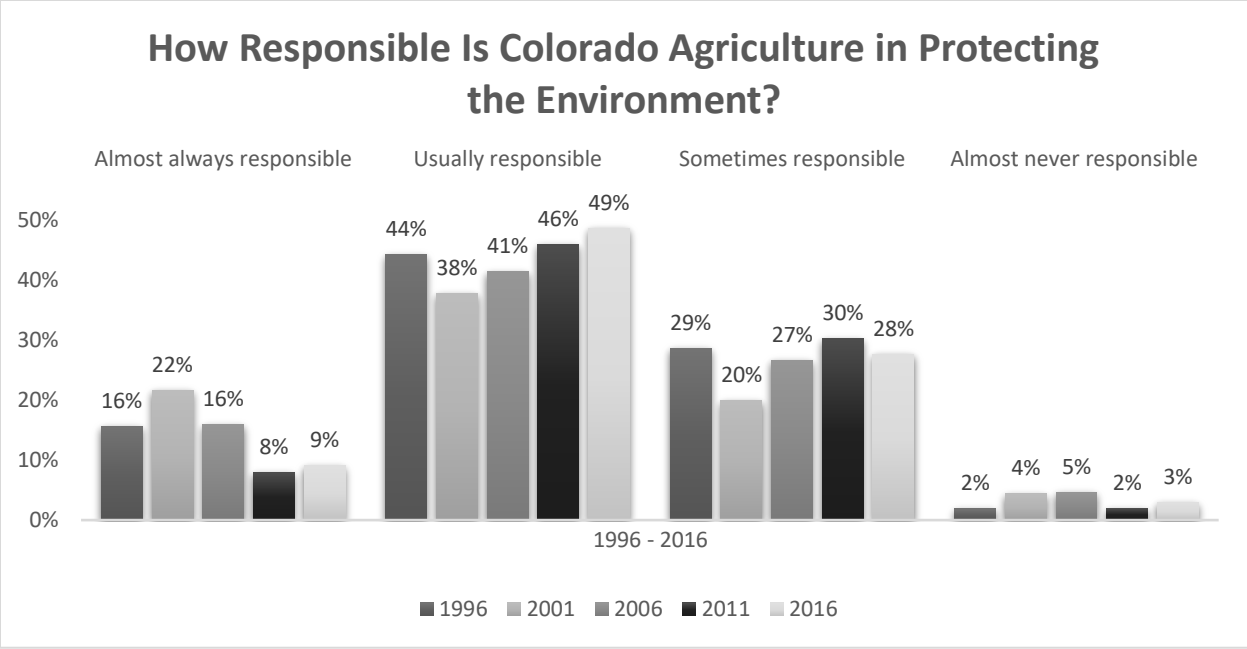

*Figure 15: Explanatory variable, **resp** (Colorado Public Attitudes Survey, 2017)*

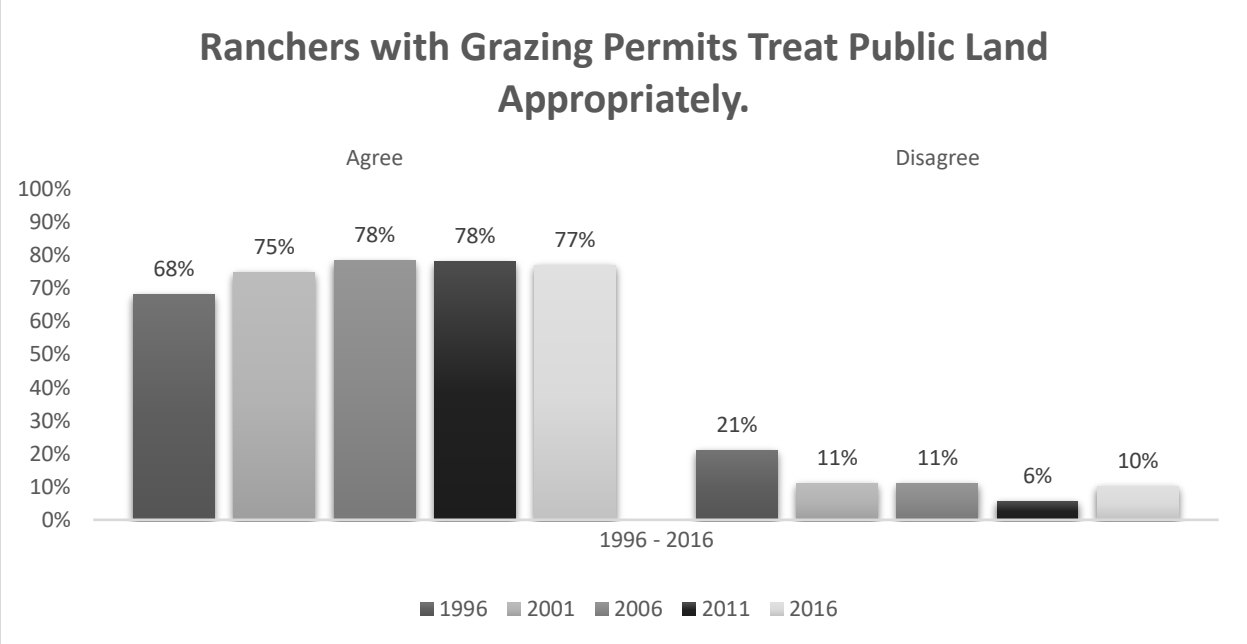

*Figure 16: Explanatory variable, **permits** (Colorado Public Attitudes Survey, 2017)*

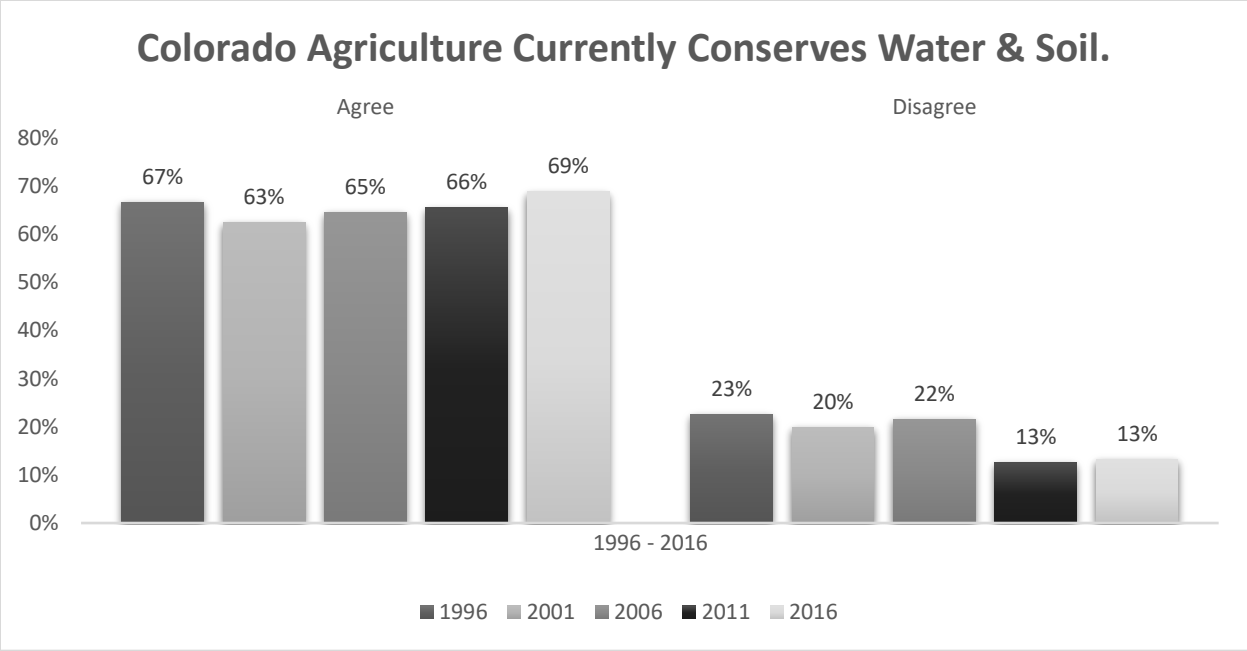

Figure 17: Explanatory variable, ***conserve*** *(Colorado Public Attitudes Survey, 2017)*

These variables are collectively intended to paint a picture of the driving characteristics behind Coloradan's attitudes and perceptions toward the use of public funds for the conservation of agricultural and natural resources. It may not seem necessary to show how respondent's views have changed over time. However, the reader will recall that Chapter 2 focused its attention on a similar topic, but the time period studied in that case was 1995-2005. These survey results are from 2016. Responses above were presented over time to show the reader how little public perceptions have changed over the last twenty years. Given the small degree of temporal variation, it does not seem unreasonable to draw comparisons between the analyses presented in the two chapters even though the time periods analyzed do not overlap.

3.4 Results and Discussion

Factor analysis was the first task performed. All results were obtained using STATA. Initial outcomes indicated a more effective model could be specified by using the Varimax rotation, and the resulting proportion of explained variance and factor loads are presented in

Table 8. *Factor 1*, *Factor 2*, and *Factor 3* were all identified as significant in explaining variance in the data. Using the criteria that all factor loads greater than 0.4 are significant, it is clear that *Factor 1* explains responses to *imp*, *devel*, *os*, and *quality*. This can be thought of as an indicator of the value respondents place on agriculture's continued existence in Colorado.

Table 8: Results of Factor Analysis

	Factor1	Factor2	Factor 3
Proportion	0.45	0.37	0.28
		Loading	
relate	0.068	0.034	0.026
resid	-0.133	-0.086	-0.057
inc	0.116	0.023	0.032
locate	0.006	0.054	0.111
econ	0.237	0.117	0.088
imp	0.567	0.089	0.195
devel	0.665	-0.060	-0.013
os	0.664	0.001	0.102
resp	0.095	0.131	0.479
permits	0.115	0.149	0.549
conserve	0.161	0.131	0.586
water	0.057	0.787	0.079
wildlife	0.048	-0.787	-0.069
quality	0.500	0.061	0.225

Factor 2 shows the strongest correlation with survey variables *water* and *wildlife.* As these responses come from the same question (Figure 10), it is not surprising that their correlations are opposite in sign and nearly equal in magnitude. Their significance in explaining overall variance in the data shouldn't come as a great surprise either. Water is a contentious and polarizing issue in Colorado and these variables appear to do a better job of capturing this ideological division than any of the others included in the analysis. In fact, this could be thought of as a measure of respondent's views toward human interaction with the environment. Some strongly feel nature should be left "as it is" and that water should be left in the rivers. Others

believe nature is here to be harnessed and utilized by humans and, therefore, water should be used to grow food.

Factor 3 explains responses to *resp*, *permits*, and *conserve*. This can be thought of as representing respondents' perception of agriculture's relationship with the environment. The numbers in the second row (Proportion) represent the variance explained by each factor as a proportion of the total variance captured by all factors in the rotated model. The fact that the sum of these is greater than one indicates that the factors are correlated.

The next stage of this research involves use of an ordered probit model to analyze how each independent variable or factor affects the probability a given respondent supports use of public funds for conservation of agricultural natural resources. Given that three underlying factors appear to explain responses to a number of variables, the decision was made to specify and estimate four models. This was done for two reasons. First, it serves as a robustness check on both model and variable significance. Second, it allows for a more nuanced explanation of the relationship between the underlying factors and the variables they help explain. Model 1 is estimated with all variables used in the factor analysis as well as *age* and *gender*. Model 2 replaces *imp*, *devel*, *os*, and *quality* with Factor 1, a continuous, orthonormal variable resulting from the above factor analysis. Model 3 is estimated by keeping Factor 1 and including Factor 2 in place of *water* and *wildlife*. Finally, Model 4 keeps Factor 1 and Factor 2 and replaces the variables *resp*, *permits*, and *conserve* with Factor 3. Results from the first two estimations are presented in Table 9 and results from the second two estimations are presented in Table 10.

*Table 9: Results of the Ordered Probit Analysis. Model 1 includes all variables in the analysis. Model 2 replaces **imp**, **devel**, **os**, and **quality** with **Factor 1**.*

	Model 1				**Model 2**			
	Pseudo-R^2	0.1953			**Pseudo-R^2**	0.1858		
	χ^2 (15)	246.99			**χ^2 (12)**	235		
n = 704								
	Coef.	Std. Err.	z		Coef.	Std. Err.	z	
relate	0.019	0.116	0.160		0.028	0.114	0.250	
age	0.010	0.003	3.180	***	0.012	0.003	3.760	***
resid	-0.026	0.040	-0.670		-0.007	0.039	-0.170	
gender	-0.003	0.102	-0.030		0.018	0.101	0.170	
inc	0.014	0.025	0.550		0.002	0.025	0.060	
locate	0.101	0.099	1.020		0.103	0.098	1.050	
econ	0.140	0.103	1.350		0.021	0.104	0.200	
imp	0.187	0.109	1.720	*	-	-	-	
devel	0.162	0.048	3.380	***	-	-	-	
os	0.405	0.054	7.480	***	-	-	-	
resp	-0.193	0.081	-2.390	**	-0.177	0.080	-2.220	**
permits	0.147	0.054	2.690	***	0.155	0.053	2.910	***
conserve	0.225	0.064	3.530	***	0.228	0.063	3.590	***
water	-0.123	0.155	-0.800		-0.172	0.154	-1.120	
wildlife	0.275	0.187	1.470		0.178	0.187	0.950	
quality	0.078	0.090	0.880		-	-	-	
Factor1	-	-	-		0.788	0.067	11.690	***
Factor2	-	-	-		-	-	-	
Factor 3	-	-	-		-	-	-	
Omega	1.39				1.37			

*Significance Levels: * = 10%, ** = 5%, *** = 1%*

Many of the survey response questions had a 'don't know' option. These responses were omitted, thus the number of responses estimated and analyzed is smaller than the sample of 1000 respondents who responded to the survey. As can be seen from the model diagnostics, all three models are statistically significant. Each Pseudo-R^2, a measure of explanatory power for models in the probit family, is on par with the literature. Further, as expected, increasing the number of

explanatory variables increases the Pseudo-R^2 value. It is also worth noting that *Omega*, the width of the neutral category under the normal curve, remains fairly consistent. This supports the notion that the results are stable among all four models.

*Table 10: Results of the Ordered Probit Analysis. Model 3 replaces variables **water** and **wildlife** with Factor 2 and Model 4 replaces variables **resp**, **permits**, and **os** with Factor 3.*

	Model 3				**Model 4**			
	Pseudo-R^2	0.1858			**Pseudo-R^2**	0.1733		
	χ^2 (15)	235.06			**χ^2 (12)**	219.25		
n = 704								
		Std.				Std.		
	Coef.	Err.	z		Coef.	Err.	z	
relate	0.030	0.114	0.260		0.030	0.113	0.260	
age	0.012	0.003	3.820	***	0.012	0.003	3.730	***
resid	-0.009	0.039	-0.230		0.002	0.039	0.050	
gender	0.018	0.101	0.180		-0.022	0.100	-0.220	
inc	0.002	0.025	0.070		0.001	0.025	0.050	
locate	0.108	0.098	1.100		0.074	0.098	0.750	
econ	0.029	0.104	0.280		0.018	0.104	0.170	
imp	-	-	-		-	-	-	
devel	-	-	-		-	-	-	
os	-	-	-		-	-	-	
resp	-0.176	0.080	-2.210	**	-	-	-	
permits	0.155	0.053	2.920	***	-	-	-	
conserve	0.227	0.063	3.580	***	-	-	-	
water	-	-	-		-	-	-	
wildlife	-	-	-		-	-	-	
quality	-	-	-		-	-	-	
Factor1	0.783	0.067	11.750	***	0.795	0.066	12.030	***
Factor2	-0.161	0.062	-2.580	***	-0.139	0.061	-2.270	**
Factor3	-	-	-		0.284	0.070	4.030	***
Omega	1.37				1.35			

*Significance Levels: * = 10%, ** = 5%, *** = 1%*

It is important to recognize that coefficients represent the direct relationship between the explanatory variable and the dependent variable. In other words, a negative coefficient suggests the associated variable moves the probability of supporting conservation to the left (toward the 'Agree' category) under the normal curve, increasing the likelihood of support for conservation. The opposite is true of positive coefficients.

There are a number of results worth noting either for their significance or lack thereof. First, of the demographic variables, *age* is the only one that is significant. Based on previous literature (Kotchen and Powers, 2006), it was not clear what to expect of this relationship. However, these results are clear: younger Coloradans are more likely to support conservation of agricultural resources. The lack of a relationship between income or gender and conservation is surprising, given results found elsewhere in the literature (Heintzelman, 2013; List, 2004; Mohai, 1992). It suggests conservation is valued equally between men and women, and by all income levels. This perhaps indicates demand for conservation may be much more evenly distributed among Coloradans than among citizens elsewhere in the country where conservation programs have been developed and analyzed.

Perhaps most interesting are results relating to the underlying factors. *Factor 1* is statistically significant in all three models that include it and helps explain responses to four variables: *imp*, *devel*, *os*, and *quality*. However, in the model where all variables are included, some have different levels of significance. For instance, *quality* shows no statistical relationship and *imp* is only significant at the 10% level. By contrast, *devel* and *os* are highly significant. The variable pertaining to open space programs, *os*, also has a large magnitude, suggesting a strong relationship with views toward conservation. Interestingly, the value respondents place on open

space is manifested in the mechanisms by which they think related resources should be conserved and not in responses specifically pertaining to the perceived value of agriculture.

Factor 2 also exhibits some interesting characteristics. Notably, the two factors it helps to explain have no statistical significance in the two models that include them. However, *Factor 2* is quite statistically significant in the two models in which it is directly included. This may be due to the fact that this factor captures the ideological polarization of beliefs regarding mankind's interaction with the environment, as discussed above.

There is also an interesting trend with *Factor 3*, which is statistically significant at the 1% level in the final model. It appears that respondent's views of conservation are indeed more robust than simply being defined by whether or not farmers and ranchers are conserving resources and treating public lands appropriately. These results indicate a negative relationship with *resp* and a positive one with *permits* and *conserve*. At first glance, this may appear somewhat confusing and will be addressed in more detail in the discussion of marginal effects. All three of these variables also have fairly large magnitudes suggesting they play a strong role in defining views toward conservation.

Tables 11, 12, 13, and 14 show the marginal effects for Model 1, Model 2, Model 3 and Model 4, respectively. The signs on each marginal effect are opposite those of the coefficient in the model estimation. This is because the marginal effect is a measure of the change in probability of the dependent variable falling into a given response category, given a change in an independent variable. The only continuous explanatory variables are *age*, *Factor 1*, *Factor 2*, and *Factor 3*. The marginal effect of *age* can be interpreted as the change in probability of falling into a specific category given a one year increase in age.

Table 11: Marginal Effects and the predicted probability for inclusion in each feedback category for Model 1

	Agree		**Neutral**		**Disagree**	
Predicted Prob.	0.598		0.305		0.097	
δ-Method Std. Err.	0.016		0.016		0.010	
	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.
relate	-0.0056	0.0349	0.0033	0.0205	0.0023	0.0145
age	-0.0031	0.0010	0.0018	0.0006	0.0013	0.0004
resid	0.0080	0.0120	-0.0047	0.0070	-0.0033	0.0049
gender	0.0010	0.0309	-0.0006	0.0181	-0.0004	0.0128
inc	-0.0041	0.0075	0.0024	0.0044	0.0017	0.0031
locate	-0.0304	0.0299	0.0178	0.0175	0.0126	0.0124
econ	-0.0422	0.0311	0.0247	0.0182	0.0175	0.0130
imp	-0.0565	0.0326	0.0331	0.0192	0.0234	0.0136
devel	-0.0488	0.0142	0.0286	0.0085	0.0202	0.0061
os	-0.1223	0.0151	0.0717	0.0097	0.0506	0.0072
resp	0.0581	0.0241	-0.0341	0.0142	-0.0241	0.0102
permits	-0.0442	0.0162	0.0259	0.0095	0.0183	0.0069
conserve	-0.0678	0.0188	0.0397	0.0111	0.0280	0.0082
water	0.0372	0.0466	-0.0218	0.0273	-0.0154	0.0194
wildlife	-0.0830	0.0562	0.0487	0.0329	0.0344	0.0235
quality	-0.0237	0.0270	0.0139	0.0158	0.0098	0.0112

Model 1 results indicate that a one year increase in age is associated with a 0.31% decrease in the likelihood of agreeing that public funds should be used for conservation of agricultural resources, a 0.18% increase in the likelihood of being neutral, and a 0.13% increase in the likelihood of disagreeing with use of public funds for conservation. In other words, an increase in age is associated with a decrease in the likelihood of support. All other marginal effects are interpreted in an analogous manner, as explained previously.

Table 12: Marginal Effects and the predicted probability for inclusion in each feedback category for Model 2

	Agree		**Neutral**		**Disagree**	
Predicted Prob.	0.599		0.305		0.097	
δ-Method Std. Err.	0.016		0.016		0.010	
	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.
relate	-0.0087	0.0348	0.0050	0.0202	0.0036	0.0146
age	-0.0036	0.0009	0.0021	0.0006	0.0015	0.0004
resid	0.0021	0.0120	-0.0012	0.0070	-0.0009	0.0051
gender	-0.0054	0.0309	0.0031	0.0179	0.0023	0.0130
inc	-0.0005	0.0076	0.0003	0.0044	0.0002	0.0032
locate	-0.0315	0.0299	0.0183	0.0174	0.0132	0.0126
econ	-0.0063	0.0316	0.0036	0.0183	0.0026	0.0133
resp	0.0540	0.0241	-0.0313	0.0140	-0.0227	0.0103
permits	-0.0471	0.0160	0.0273	0.0093	0.0198	0.0069
conserve	-0.0693	0.0189	0.0402	0.0111	0.0291	0.0083
water	0.0523	0.0467	-0.0303	0.0271	-0.0219	0.0197
wildlife	-0.0541	0.0568	0.0314	0.0330	0.0227	0.0240
Factor1	-0.2401	0.0162	0.1393	0.0117	0.1008	0.0102

At the top of each category the predicted probability is presented. In all cases, these estimates are statistically significant. They are also consistent across models, lending yet more credence to the robustness of the results. As a final check on model accuracy, these three predicted probabilities were compared with the feedback to the question from which the dependent variable was drawn. The models predict that about 60% of respondents should fall in the 'agree' category, about 30% should fall in the 'neutral' category and about 10% should fall in the disagree category. Table 15 compares these three results to the actual proportion of respondents that fell into each category, as presented in Figure 18. The model appears to slightly over-predict the proportion that agree and slightly under-predict the proportions that are neutral and disagree.

Table 13: Marginal Effects and the predicted probability for inclusion in each feedback category for Model 3

	Agree		**Neutral**		**Disagree**	
Predicted Prob.	0.599		0.305		0.097	
δ-Method Std. Err.	0.016		0.016		0.010	
	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.
relate	-0.0092	0.0348	0.0053	0.0202	0.0038	0.0146
age	-0.0036	0.0009	0.0021	0.0006	0.0015	0.0004
resid	0.0027	0.0120	-0.0016	0.0070	-0.0011	0.0050
gender	-0.0055	0.0308	0.0032	0.0179	0.0023	0.0129
inc	-0.0006	0.0075	0.0003	0.0044	0.0002	0.0032
locate	-0.0328	0.0299	0.0190	0.0174	0.0138	0.0126
econ	-0.0088	0.0317	0.0051	0.0184	0.0037	0.0133
resp	0.0537	0.0241	-0.0312	0.0140	-0.0226	0.0103
permits	-0.0472	0.0160	0.0274	0.0093	0.0198	0.0069
os	-0.0690	0.0189	0.0400	0.0110	0.0290	0.0083
Factor1	-0.2386	0.0159	0.1384	0.0116	0.1002	0.0101
Factor2	0.0490	0.0187	-0.0284	0.0109	-0.0206	0.0081

Factor 1 and all the variables it helps explain have a negative relationship with support for conservation. The higher the ordinal value of the response to each of the independent variables (*imp*, *devel*, *os*, and *quality*) the more negative the response. In other words, an increase of one unit in *devel* indicates a decrease in respondent support for using public funds to purchase development rights as a way of conserving agricultural resources. According to Table 11, this decreases the likelihood of agreement by 4.9%. Clearly, those who do not believe it is important to maintain land and water in agricultural use, and do not support the use of public funds to purchase development rights or help open space programs conserve resources, also don't support the use of public funds to help farmers conserve agricultural resources. This is not surprising and is, in fact, quite intuitive.

Table 14: Marginal Effects and the predicted probability for inclusion in each feedback category for Model 4

	Agree		**Neutral**		**Disagree**	
Predicted Prob.	0.598		0.304		0.097	
δ-Method Std. Err.	0.016		0.017		0.010	
	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.	Marginal Effect	δ-Method Std. Err.
relate	-0.0093	0.0352	0.0054	0.0204	0.0039	0.0147
age	-0.0036	0.0009	0.0021	0.0006	0.0015	0.0004
resid	-0.0006	0.0121	0.0003	0.0070	0.0002	0.0051
gender	0.0068	0.0310	-0.0039	0.0180	-0.0028	0.0130
inc	-0.0003	0.0076	0.0002	0.0044	0.0001	0.0032
locate	-0.0229	0.0304	0.0133	0.0177	0.0096	0.0128
econ	-0.0054	0.0321	0.0032	0.0187	0.0023	0.0135
Factor1	-0.2466	0.0158	0.1433	0.0116	0.1033	0.0103
Factor2	0.0430	0.0187	-0.0250	0.0108	-0.0180	0.0081
Factor 3	-0.0881	0.0212	0.0512	0.0124	0.0369	0.0095

Factor 2 increases the probability of support for conservation of agricultural resources. However, there is an interesting underlying pattern in the two variables (*water* and *wildlife*) whose responses it helps to explain. In Model 1, *wildlife* has a negative effect on support that is more than twice the magnitude of *water*'s effect. In Model 2, however, the two magnitudes are nearly identical and offsetting. Factor 2 is introduced in Model 3 and has an overall positive relationship in both this and Model 4. In both cases the magnitude is nearly the same. These results are the least robust of those that are statistically significant and it is difficult to pinpoint the reason behind this ambiguity.

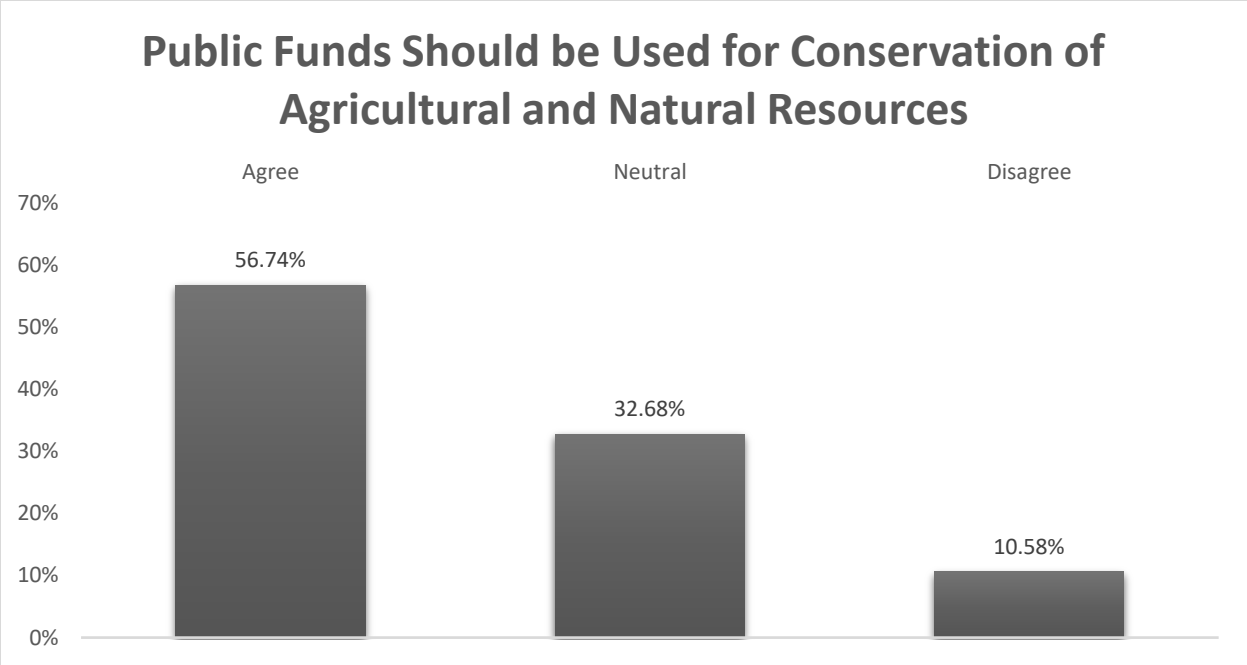

Figure 18: Survey Feedback to the Question Estimated by the Ordered Probit Models

The final underlying driver, *Factor 3*, has a negative relationship with views toward using public funds for conservation. This suggests that the more negatively respondents view agriculture's relationship with the environment, the less likely they are to support use of public funds by farmers to conserve agricultural resources. Interestingly, the variables driven by this factor have different signs. Those who believe farmers and ranchers are doing a poorer job of conserving soil and water or treating public lands appropriately are also less likely to support the use of public funds for conservation. However, those less likely to believe agriculture is acting in an environmentally friendly way are more likely to support this type of conservation. As stated above, this indicates a view of agriculture's relationship with the environment that is more subtle and dependent on perceptions of how effectively producers steward resources.

Table 15: Comparison of Predicted Probabilities of Conservation Support with Survey Feedback

	Agree	Neutral	Disagree
Survey	0.567	0.327	0.106
Model 1	0.598	0.305	0.097
Model 2	0.599	0.305	0.097
Model 3	0.599	0.305	0.097
Model 4	0.598	0.304	0.097

The former responses are intuitive. If farmers and ranchers are already perceived as treating public lands appropriately and conserving soil and water resources, it is reasonable to expect that using public funds to help them further conserve resources would achieve the desired outcomes. The latter response is less intuitive. However, it may be that Coloradans who view agriculture's relationship with the environment in a negative light do so only because they believe farmers and ranchers need to be incentivized to conserve resources. If this is the case, these results make sense, as respondents view the use of public funds as an effective tool to provide the necessary incentive.

Collectively, these results indicate some important and straightforward relationships between explanatory variables, underlying factors and support for use of public funds to conserve agricultural resources. For instance, those who support conservation appear to do so independent of the public support mechanism. In other words, they don't care if the public funds are used to purchase development rights, help county and municipal open space programs or incentivize farmers. They only care that agricultural resources are ultimately conserved. Likewise, those who believe farmers are doing a good job of conserving resources and treating public lands appropriately believe public funds should be used to help farmers and ranchers continue to conserve resources.

3.5 Conclusion

This research provides policy makers and interested parties with the tools necessary to better understand their constituents as they craft (or choose whether to craft) policies or referenda regarding the conservation of agricultural natural resources, including soil, water and open space. It is expected that better informed policy makers design more effective and better supported policies, perhaps leading to results which are of greater benefits to a greater number of people. Rather than focusing on factors responsible for passage or failure of conservation policies, this study identifies factors that influence public attitudes towards conservation policies and approaches.

There were three objectives to this research. The first was interested in the relationship between support for conservation of agricultural natural resources and direct experience with agriculture. The analysis in this chapter suggests no such a relationship exists. The second objective focused on understanding the relationship between support for agricultural natural resources and demographic characteristic such as age, location, length of residency, gender and income. While no statistically significant patterns were discovered for most of these factors, age does play a role in support for conservation. Specifically, younger people are more likely than their elders to support use of public funds for conservation of agricultural resources, perhaps suggesting a longer-term view of how such conservation will benefit them and their environs. It is also worth noting that the lack of relationships between views on conservation and income or gender were unexpected, given that these factors have been found to be significant by researchers in other parts of the country. This suggests regional differences in attitudes and perceptions toward conservation.

The third objective examined the relationship between support for conservation of agricultural natural resources and a number of related questions in the survey. Using factor analysis, nine of the ten original responses were collapsed into three new variables which were determined to explain most of the variance in the corresponding variables. The first of these factors can be thought of as the value a given respondent places on the continued existence of agriculture in the state of Colorado. The second is not as straightforward but appears to be a measure of ideological polarization relating to human interaction with the environment. Finally, the third can be thought of as measuring respondents' perceptions of agriculture's relationship with the environment.

The ordered probit model was run using four different specifications. The first included all variables. The second included *Factor 1* in place of several variables. The third included *Factor 1* as well as *Factor 2* in place of several more variables. The final specification included *Factor 1*, *Factor 2*, and *Factor 3* in place of all but one of the variables pertaining to survey questions. Estimates varied little across the models indicating the robustness of results regardless of specification. However, comparison of statistical significance between the underlying factors and the variables they explain indicates that attitudes and perceptions of Coloradans toward conservation of agricultural natural resources are somewhat complex.

What does this mean for policy makers, nonprofits, or other individuals or organizations interested in conversation of natural resources for agriculture? First, as with many more socially liberal issues, young people appear to be the strongest supporters of agricultural and natural resource conservation. This likely indicates that policies supporting these issues will only become more pertinent in the future. Likewise, these outcomes indicate that Coloradans who support conservation do not have a preferred mechanism by which natural resources should be

conserved. In other words, Coloradans care more about outcomes than the mechanisms by which they are achieved. It also appears that those who believe farmers and ranchers properly care for public lands and conserve water and soil are more likely to support the use of public funds to help farmers and ranchers with conservation. Interestingly, those who think agriculture has a poor relationship with the environment believe this can be remedied by using public funds to incentivize conservation efforts by farmers and ranchers.

Ultimately, these results provide policy makers and interested parties with a more subtle and nuanced understanding of their constituents. Without data from sources such as the Colorado Public Attitudes Survey, this would be nearly impossible. Surveys such as this can be of great value helping define which communities are likely to support conservation and which are not. The implementation of such surveys in other states would prove useful not only to policy makers and analysts within the states, but also as a means of comparison between states and regions. Results from this paper suggest regional differences in attitudes toward conservation, something that could easily be corroborated if other states implemented similar public attitude surveys.

There is considerable room for future work in this area. Correlation does not imply causation, meaning this study can say nothing about why, for instance, supporters of conservation of agricultural natural resources tend to be younger. Understanding the causation behind such patterns would be of great interest to academics and policy makers alike. As mentioned above, it would also be of value to repeat this analysis in various states or regions of the country to determine if the attitudes and perceptions of residents in Colorado are representative of regional or national trends.

CHAPTER 4 - CONCLUSION

An assessment of the underlying drivers behind conservation of agricultural resources in the state of Colorado is both timely and relevant. The research is approached from two distinct angles. First, demographic and policy characteristics motivating the appearance and passage of conservation referenda on county and municipal ballots is investigated. Second, using data from a statewide survey, the perceptions and attitudes of Coloradans toward conservation of agricultural and natural resources are examined. Together, results from the two components of this study allow for the examination of whether Coloradans act the way they say they are going to act when it comes to public-facing issues like conservation: in short, do stated and revealed preferences align. More broadly, understanding the factors driving interest in and action to conserve natural resources is of value to policy makers and relevant stakeholders both in Colorado and beyond its borders.

Chapter 2 investigated characteristics associated with the appearance and passage of conservation referenda on ballots in the state of Colorado. Here, research focused on referenda which represent Coloradan's revealed preferences for conservation. Results from this chapter are particularly germane as prior literature on the topic focuses almost exclusively on the East Coast of the U.S. Given the social, cultural, geographic, and ecological differences between the states of Colorado and New Jersey or Connecticut, there is reason to believe outcomes may vary between the two places. Chapter 2's results provide policy makers in Colorado and other Western states the ability to make more informed decisions about the conservation of natural resources. For instance, previous literature suggests a significant, positive relationship between income and conserving environmental goods, including conservation of public goods such as

open space and natural resources. However, this relationship was not found in Colorado. Lack of such a relationship could imply the existence of strong environmental concern among the citizenry regardless of income. These findings suggest more uniform distribution of the demand for conservation policies in the West than in the Mid-Atlantic or New England states.

Characteristics increasing the likelihood of a conservation referendum appearing on a ballot in Colorado are varied, including total population, greater educational attainment among the population, adoption of home rule charter, lower proportion of white residents, and pre-existing support for conservation in a given jurisdiction. Once a conservation initiative does appear on the ballot, higher educational attainment is the only demographic variable correlated with an increased likelihood of success. In the primary model specification, this variable is only significant at the 10% level. However, when the model was tested for robustness, the variable dropped below this threshold, suggesting it is less stable than other significant results. As discussed in Chapter 2, it is possible this finding and its inconsistency may be due to the same type of spatial autocorrelation identified by Heintzelman (2013). In other words, there may be unobserved underlying characteristics that attract highly educated people to particular places which, in turn, could increase the likelihood of support for conservation in such communities.

The majority of referenda introduced during the time period analyzed were directed toward open space conservation and most of these passed, indicating demand for open space, in general. Specifically directing outcomes toward open space and wildlife appears to increase the likelihood of passage, relative to simply focusing on open space. In contrast, directing funds toward both open space and agricultural resources, or open space and water, conjointly, decreases the likelihood of passage, relative to simply focusing on open space. The latter two outcomes are not intuitive. Between 2002 and 2007, average direct marketing sales for Colorado

farms, a measure of growth within the local food movement, increased by nearly 10% (Graff, 2013). Considering this level of support for local food and farmers, the result showing less direct support for agricultural production is perplexing. A possible explanation may be that residents view the state's eastern plains as dedicated largely to agriculture and, given the portion of the state this covers, feel no need to conserve additional, related resources. The water result is also surprising considering water's importance as an environmental issue in the state. One potential explanation is that Coloradans may believe water issues are too big to be dealt with at the municipal or county level and should be overseen by the state, or even federal government. Results also appear to suggest that Coloradans prefer some methods of conservation (those focused on wildlife) to others (those focused on farmland or water). Additionally, it is worth noting that neither household income nor number of children played a significant role in demand for conservation referenda, contrary to previous literature. Again, this suggests a more even distribution of demand for environmental goods in Colorado than in other states where similar studies have been performed.

Chapter 3 investigated the perceptions and attitudes of Coloradans toward conservation of agriculture and natural resources such as soil, water, and open space. This research was based on survey results from a representative sample of Coloradans and identifies residents' stated preferences. Here, research focused on three different characteristics. First, it explored the relationship between supporting the use of public funds for conservation of wildlife habitat and agricultural natural resources and the respondent's direct relationship with agriculture. Second, it investigated the role demographic characteristics play in affecting the likelihood of supporing conservation. Finally, answers to several questions related to use of public funds for conservation

and agriculture's relationship to the environment were analyzed to determine how opinions on similar topics affect the likelihood of supporting conservation.

Factor analysis determined three underlying themes explained much of the variation in feedback to conservation values-based questions. The first appears to be a measure of the value Coloradans place on agriculture's continued existence in the state. Factor 2 appears to be correlated with the ideological continuum of views toward human interaction with the environment. The third is an indicator of how residents view agriculture's relationship with the environment. The ordered probit analysis that followed was run under four specifications. Each included all demographic variables as well as the measure of respondents' relationship to agriculture. The first model included all other variables as well. In the second, factor 1 replaced the variables associated with it. Building on this, Factor 2 replaced the variables associated with it in the third model. And, finally, the last model was run with all three factors replacing their associated variables. Results changed little under these varied specifications, indicating they are robustness regarding the direct inclusion of variables as compared to underlying factors.

Model results indicate Coloradans' relationship to agriculture and most demographic factors do not affect their likelihood of supporting the use of public funds to conserve agricultural natural resources. Age, however, does play a role. Younger respondents are more likely than older ones to support conservation. Factor 1, the measure of how respondents value agriculture's continued existence, is also statistically significant, as are three of its four associated variables. Ironically, the direct, existential measure of how Coloradans value agriculture relative to quality of life does not play a significant role in determining views toward these resources. As the value of the variables that are statistically significant increase, the likelihood of supporting use of public funds for conservation of agricultural resources decreases.

In other words, Coloradans who are less likely to support the use of public funds for conserving agricultural resources via purchase of development rights or through government open space programs are also less likely to support use of public funds by farmers to conserve these resources. This appears to suggest that Coloradans say they support conservation of agricultural resources independent of the mechanism by which these ends are achieved.

The second factor is also statistically significant. Individually, though, the variables it helps explain are not, suggesting that only collectively do the two variables play an important role in explaining views toward conservation. This is likely due to the fact that these variables act in opposite directions and cancel each other out if not accounted for jointly. The factor capturing views about agriculture's relationship to the environment is also statistically significant, as are all three of the variables associated with it. As the variables associated with agriculture's current success at conserving soil and water and treatment of public land increase, the likelihood of supporting use of public funds for conservation decreases. This is expected. The less likely Coloradans are to believe ranchers treat public lands appropriately or that farmers conserve soil and water, the less likely they are to support the channeling of public funds to farmers and ranchers to help conserve these resources. However, as the respondents' belief that agriculture acts in an environmentally responsible way increases, so does support for conservation. At first glance, this is not as intuitive. Apparently, the more likely residents are to believe agriculture does not have a good relationship with the environment, the more likely they are to support the use of public funds by farmers to conserve agricultural resources. It is possible that Coloradans believe farmers are not being properly incentivized to take care of the environment and feel that government funds would provide the motivation necessary to increase conservation. This is an interesting avenue for future research and policy analysis.

There are several key outcomes of this research. First, those who are younger and better educated are the most likely candidates for supporting conservation of agricultural resources. Second, the stated and revealed preferences of Coloradans concerning conservation are not fully aligned. When asked directly, residents appear to support all forms of conservation, independent of mechanism. However, in the voting booth they display clear preferences regarding how conservation dollars should be spent. For instance, those who specifically state that they support maintaining in-stream flows for wildlife as the top priority for water usage during a dry year are less likely to support use of public funds for conservation wildlife habitat and agricultural resources. However, analysis of referenda data indicates that including wildlife as a conservation goal on referenda increases the likelihood of passage, while targeting water decreases this likelihood. In other words, some Coloradans appear to support conservation of water in theory but not in practice, while supporting conservation of wildlife in practice but not in theory.

Finally, neither gender nor income are factors that drive views toward conservation, contrary to expectations and results found elsewhere in the country. In other words, demand for conservation appears to be more evenly distributed in Colorado. This should not be surprising. Colorado offers a set of natural amenities that are in short supply in other regions of the country. Therefore, it is not unreasonable to believe those who live (or have chosen to migrate) here both utilize and value these amenities and the associated resources, making them more likely to support related conservation efforts.

It should also be noted that without the Colorado Public Attitudes Survey, this analysis would be challenging at best. The existence of a longitudinal, representative sample of Coloradans contains valuable information that can be used to identify and address the subtle factors pertaining to conservation attitudes and perceptions. Likewise, it allows for the direct

comparison of what residents say with what they do. It would behoove other states to consider implementing similar surveys in order to gain a more robust and nuanced understanding of the characteristics driving residents' views on agricultural and environmental issues as future policies in this sector are framed.

Policy makers and interested parties can draw a number of inferences from the research presented here. First, demand for conservation appears to be strong and evenly distributed in the state of Colorado, suggesting it likely varies by region across the country. The results presented here may provide insights for nearby states and prove particularly useful to policy makers and concerned organizations in regions similar to Colorado. Second, because stated preferences for conservation are uniform, the differences in revealed preferences may have more to do with framing than the actual wording on the ballot. Strategic messaging is likely to increase the probability of success. In other words, it matters more how the story surrounding a particular conservation initiative is told than what exactly the proposal says. Finally, because younger, better educated Coloradans are more likely to support conservation, it is likely to remain an important future issue in the policy arena.

Finally, there are several weaknesses in this study that must be acknowledged. As a whole, it is difficult to compare stated preferences for open space conservation (Chapter 2) with revealed preferences for agricultural resources (Chapter 3) as a means of determining general voter sentiment. While this is not perfect, it does shed some light on overall support for conservation in Colorado. It also opens the door to further research. A more specific weakness is the failure to directly address spatial autocorrelation in Chapter 2. While it was handled in a somewhat oblique manner and its presence circuitously identified, until it is addressed directly, its true impact remains ill-defined. This is also an important area of further research identified by

this paper. Very few of the previous studies in this area addressed spatial concerns. Of these, the most recent, Heintzelman et al. (2013), makes a compelling case for focusing on this issue. At first glance, it would also appear that an additional shortcoming has to do with the time period analyzed in Chapter 2. However, the argument could also be made that this provides the best means for comparison and identification of potential regional differences, as nearly all other similar studies (which focused almost exclusively on the East Coast) were performed over roughly the same time.

It is also important to acknowledge that Chapter 3 is somewhat less rigorous insofar as the groundwork that is laid out to motivate it. Few studies have proceeded in this manner in part because identifying individual attitudes and perceptions does not necessarily extrapolate well to the general public. However, if other states were to perform surveys similar to the Colorado Public Attitudes Survey, a mechanism could be developed for more effectively comparing attitudes and perceptions across states and regions. This would greatly expand the possibilities for investigating public sentiment and open the door to quite a number of additional research opportunities on the political, regional and social dimensions differentially impacting conservation support across the US.

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