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BIODIVERSITY CONSERVATION VERSUS WIND POWER DEVELOPMENT IN THE STATE OF OKLAHOMA: ASSESSING OPINION WHERE GREEN INTERESTS COLLIDE

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BY THE COMMITTEE CONSISTING OF

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Abstract

Wind energy development represents one pursuit in sustainable technology meant to reduce negative impacts on the environment. Wind energy, however, may not be environmentally benign, as these activities can conflict or compete with other green interests, such as wildlife conservation. This research examines the perceptions of environmentally conscious individuals at the intersection of wind energy development and biodiversity conservation interests. The first chapter presents an extended explanation of sustainability, wind energy development, and biodiversity conservation to assist in framing my research. Chapter two presents the research conducted, titled "The 'green on green' conflict in wind energy development: a case study of environmentally conscious individuals in Oklahoma". We used an online survey and distributed via environmentally related groups as well as at environmental events in the state of Oklahoma. We found that while participants were aware of the shifting causes of mortality of bird populations, they were less aware of the implications of wind energy on bat populations. In addition, attitudes towards biodiversity conservation as well as wind energy development were statistically significant when looking at how attitudes informed the identification of some impacts. Participants were also willing to support wind energy development if it had no impacts on biodiversity conservation, regardless of the trade-off presented. Attitudes towards biodiversity conservation were statistically significant in predicting almost all of these trade-offs. Lastly, various demographic factors such as gender and political affiliation were statistically significant when analyzing trade-off responses, but less demographic variables were statistically significant when analyzed in the context of the presented attitude questions. In the third chapter, I present an

extended discussion of the results of my paper as well as avenues for future research using this data set.

Keywords: Oklahoma, wind energy, green on green, public perception, sustainability

Chapter 1: Background on Sustainability Theory and Alternative Energy Development

1.1 Sustainability Theory

Sustainability as a theory, science, and practice is relatively new; a uniform definition of sustainability practice is therefore hard to find. While earlier definitions tended to focus on resource depletion, more recent definitions have worked to include social systems as well (Gliedt and Larson, 2018). Sustainability management practices focus on a triple bottom line: economics, environment, and society.

Renewable energy can be viewed as an effort working towards a strong sustainability framework. A strong sustainable framework must maintain or increase over time human, social, and ecological capital in a particular region (Gliedt and Larson, 2018). When examining wind energy, metrics to measure its success in relation to sustainable development can be examined through all three components of the triple-bottom line. Wind energy can provide jobs and a new economic opportunity in economically depressed areas, increasing social and economic well-being, and can also lead to lower greenhouse gas emissions and pollutants, increasing environmental well-being (Alvarez-Farizo and Hanley, 2002; Groth and Vogt, 2014; Kaldellis and Zafirakis, 2011). Biodiversity conservation can also be examined utilizing the same metrics. Biodiversity conservation also offers jobs in a variety of fields, provide tourism along with job opportunity in areas that are economically depressed, add to social well-being via access to natural space, and increase environmental well-being by providing a stable ecosystem for organisms to succeed in (Rand et al., 2010).

1.1.1 Conflicting priorities in a sustainable transition

A strong sustainability framework often leads to conflicts in balancing the three pillars of sustainability. This can be seen most clearly in the context of corporate sustainability, where shifting from a mass market to a niche market to satisfy environmental protection initiatives may lead to a drop in profit margins, for example (Hahn et al., 2010). While these types of trade-offs, which lead to intricate business decisions, are more the rule than the exception, there exists another type of conflict with sustainable development implementation.

This “green on green” (or “green versus green”, as noted in some of the literature) conflict arises when a strategy to mitigate climate change leads to environmental impacts of another sort (Warren et al., 2005). Warren et al. (2005) coined the term “green on green” conflict as a “new kind of environmental controversy”. Typically, in the debate between conservation and development, environmental activists can position themselves firmly on one side of the debate. As Warren et al. (2005) describes, however, these unique “green on green” conflicts represent debates where there are solid environmental arguments on the side of development as well as on the side of conservation. Ultimately, in these conflicts, environmentalists are uniquely “pitted” against one another. This conflict is unique in the energy sector as well, because environmentalists were opponents of nonrenewable development but may be supporters of renewable energy development. Kahn (2000) in his piece on the struggle of siting renewables suggests that this could be why environmentalists are more effective at opposing renewables versus fossil fuels – because renewable energy developers were not prepared to have environmentalists in opposition. Kahn (2000) emphasizes that “renewable energy is rooted in the environmental movement.”

In the literature, this "green on green" conflict is largely rooted in wind energy development, whether it be outlining this concept (Warren et al., 2005; Warren and Birnie, 2009), evaluating public attitudes and perception towards development (Bidwell, 2013; Swofford and Slattery, 2010), looking at compensation (Groothuis et al., 2008), or even, more recently, evaluating public perceptions of offshore wind (Toonen and Lindeboom, 2015). Ultimately, the question in this conflict becomes what type of green initiative are individuals trying to achieve and at what scale should one consider when working towards this initiative (Warren and Birnie, 2009).Warren and Birnie (2005) also point out, when debating this green or green conflict, that it often ties into the adage "think global, act local" as the main divide within the conflict. Proponents on the two sides of this debate when looking at wind energy development either focus on the positive global impacts on climate change mitigation or the negative local externalities, which include the impact on the landscape, light and noise pollution, and impacts on local wildlife (Groothuis et al., 2008). The "green on green" conflict is utilized a framework for this research, as wind energy development and wildlife conservation are two conflicting ideas.

1.1.2. The value of public perception work

Technology implementation, such as building out renewable energy, is often faced with local opposition during the proposal or development phase. Understanding what this opposition is based on and how local communities respond to development can help to encourage smoother societal transitions as we implement sustainable technology (Olson-Hazboun et al., 2016). In addition to helping to secure a smoother transition, understanding the experiences of communities when it comes to sustainability and sustainable transitions (such as the energy transition) can help shed light on issues related to environmental and social justice. Communities may be experiencing uneven costs or benefits of development and it is important to highlight disparities in order to try and remedy them (Olson-Hazboun et al., 2016). Overall, communities and the experiences of individuals are extremely complex and context-specific; it is these complex experiences that shape support or opposition. It is therefore important that social scientists and other researchers continue to build literature in public perception, in order to understand how opinions are formed about sustainability and to be able to consider issues of justice and equality during implementation (Olson-Hazboun et al., 2016). When looking at the renewable energy industry specifically, as pointed out by Olson-Hazboun et al. (2016), social science research makes up less than 20% of the literature in energy studies. Social science research, however, offers an opportunity to understand the attitudes, habits, and values that shape public opinion of energy systems as well as support or opposition of future development; attitudes, habits, and values can also play a role in how policy is implemented (Olson-Hazboun et al., 2016; Sovacool, 2014) Social science research on public perception in the energy sector can help developers understand the best way to implement a clean energy transition.

In conjunction with research related to public perception, this research utilizes ideas of perception and attitudes. Opinion and perception are used interchangeably within the context of this research – while there are nuances in the definition of these terms, the baseline definition is similar enough to warrant them being used together. In order to provide clarify, the following terms are defined as follows:

1. Opinion: a thought or belief about something or someone (Cambridge Dictionary, n.d.)

2. Perception: a belief or opinion, often held by many people and based on how things seem (Cambridge Dictionary, n.d.)
3. Attitude: a feeling or opinion about something or someone, or a way of behaving that is caused by this (Cambridge Dictionary, n.d.)

Again, the similarity in opinion and perception represented above assists in justifying the use of these two words interchangeably. In public policy, the concepts of public opinion and public perception are often used synonymously, as further justification for their synonymous use in this research. Attitudes, however, is used as a separate idea; it represents the result of cognition based on beliefs and values of individuals (Shrigley et al., 1988).

1.2 Alternative Energy Development

Renewable energy is driven by its potential to provide energy security, economic and political development and stability, as well as climate change mitigation (Gasparatos et al., 2017; Ellaban et al., 2014; Kumar et al., 2016). While renewable energy systems are typically viewed as having a lower impact than fossil fuel energy production, it is important to consider the potential environmental impacts of their installation and operation (UNEP, 2011). This includes animal mortality, land use change, and development of associated infrastructure, which may lead to habitat fragmentation or loss. Goals of renewable energy are often developed without consideration for impacts on biodiversity and assessments on impacts were largely non-existent during renewable energy system construction in the past few decades (Gasparatos et al., 2017).

In the end, the conflict between choosing either renewable energy or biodiversity conservation could lead to difficult decisions in which ineffective laws are the result (Jackson, 2011). This means that favoring biodiversity conservation over renewable energy or vice versa, especially via policy, can lead to leniency or overall disregarding one or the other. It is important, therefore, to understand all associated impacts so that renewable energy is not implemented at the cost of biodiversity conservation. Wind energy is one method of renewable energy that has recently come up against this policy and implementation challenge.

1.2.1 Adoption of wind technology in the United States

Traditionally, wind farms have been developed by private investors and developers who then sell the wind energy produced to public utility companies in the United States (Bidwell, 2013). Development has the potential to boost economically-depressed rural areas, and, as these regions are often resource-rich, large portions of wind energy development are focused on rural communities (Alvarez-Farizo and Hanley, 2002; Fergen and Jacquet, 2016). Policies vary on the state level, but there are largely no policies that require developers to notify landowners (other than those who sign contracts) about development (Public Utility Division, 2014; Groth and Vogt, 2014a, 2014b; Swofford and Slattery, 2010). This is one of many issues that arises when identifying opposition associated with wind energy development.

Broadly, challenges associated with wind energy development can be broken up into four categories: economic, technological, social, and environmental. Economically, wind energy developments require large amounts of upfront capital. Kumar et al. (2016) estimates 75-85% of total project cost is upfront capital cost. There is also risk associated with investment. Because wind power can be unreliable, challenges also arise with finding technology to successfully integrate electricity produced with the grid (Kumar et al., 2016). Environmental and social challenges are often defined interchangeably when looking at literature available. Some research defines issues such as visual and noise impact as environmentally-related while others tend to group it as a social challenge. Social challenges also include lack of social acceptance, interference with telecommunication and radar signal, and potential health impacts (Jones and Eiser, 2010; Fergen and Jacquet, 2016; Swofford and Slattery, 2010; Groth and Vogt, 2014a, 2014b).

1.3 Biodiversity Conservation and Wind Energy Development

When examining wind energy, a unique conflict arises in determining the appropriate trade-off for impacts of biodiversity while attempting to move away from fossil fuel (Swofford and Slattery, 2010; Devine-Wright, 2005). Questions surrounding disturbing natural areas as well as mortality of flora and fauna due to wind energy development are just two examples of the difficulties associated with the trade-off (Alvarez-Farizo and Hanley, 2002). This “green on green” conflict frames much of the environmental-related issues within wind energy development. Research on environmental impacts of wind energy have focused on impacts on wildlife (Kunz et al., 2007; Kuvlesky et al., 2007; Loss, Will, and Mara, 2013). Other research has suggested impacts on climate as well (Leung and Yang, 2012) but this project will focus on biodiversity conservation.

1.3.1 Collision mortality due to wind farms

Current research focus on collision mortality tends to be on birds and bat mortality due to collision. Studies often did not operate under the same parameters or account for the same bias and therefore, no universal context is present when looking at this body of literature (Kunz et al., 2007; Kuvlesky et al., 2007). There is also a lack of research on pre-construction of wind energy developments that establishes a population baseline with which to examine mortality levels against (Frick et al., 2017; Loss et al., 2013; Kunz et al., 2007; Kuvlesky et al., 2007).

Overall, estimates for bird mortality due to turbine collision range from 20,000 to over 500,000 (Loss et al., 2013). A large portion of the literature cites, however, that more birds are killed annually due to other causes such as existing city infrastructure, outdoor domestic cats, etc. These counts of mortality, both due to wind turbines and other causes, are typically calculated by surveys to collect dead specimens in the study area (Marques et al., 2014; Loss et al., 2013; Kuvlesky et al., 2007). Research on bat mortality has only begun to build in recent years when researchers began discovering bat carcasses among bird carcasses at wind farms. Estimates for bat mortalities are much higher and much research hovers around a 500,000 estimate (Frick et al., 2017). Further work would need to be done but trends indicate that bats are impacted more than birds (Dai et al., 2015; Kuvlesky et al., 2007). As parts of Oklahoma lie within the path of migratory birds as they move north in the summer and the state is also home to migratory bats, collision mortality is an important environmental impact to consider.

1.3.2 Habitat loss and fragmentation from wind turbine development

Beyond direct impacts to population due to collision mortality, other environmental impacts on biodiversity include habitat loss and fragmentation as well as impacts due to supporting infrastructure such as transmission lines and roads (Loss et al. , 2013; Dai et al., 2015; Kuvlesky et al., 2007). For example, research has expanded beyond birds of flight and discusses how turbine farm development impacts flightless birds such as greater and lesser prairie chickens and their habitat. These species are sensitive to human development and farm construction often renders their habitat unsuitable (Winder et al., 2014b; Kuvlesky et al., 2007; Winder et al., 2015).

Other research, however, found that the presence of wind turbines does not have a strong impact on these species and does less harm than development of oil and gas production, indicating the need for further research (Mcnew et al, 2014; Winder et al., 2014a; Harrison et al., 2017).

1.4 Summary and structure of thesis

The intention of this research is to further understand the "green on green" conflict, as coined by Warren et al. (2005), in terms of individuals who understand both sides of the environmental argument. This conflict is a debate unique to sectors such as the renewable energy sector, where both sides of the environmental argument are based on strong evidence of costs and benefits. In Chapter Two, I explore this idea via a survey distributed to environmentally conscious individuals. Chapter Three of this document includes additional research avenues with the data collected from a survey utilized for this research, with the intent of publishing Chapter Two as a paper co-authored by R. Loraamm and T. Gliedt. This research will add literature to the growing body of research on public perception of wind energy development, focusing on a group of individuals not typically targeted by these surveys.

Chapter 2: The "green on green" conflict in wind energy development: a case study of environmentally conscious individuals in Oklahoma

2.1 Abstract

Wind energy development represents one pursuit in sustainable technology meant to reduce negative impacts on the environment. Development in wind energy technology and deployment of infrastructure reduces reliance on fossil fuels and can further energy security goals. Wind energy, however, may not be environmentally benign, as these activities can conflict or compete with other green interests, such as wildlife conservation. This research examines the perceptions of environmentally conscious individuals at the intersection of wind energy development and biodiversity conservation interests. We employed an online survey as distributed via environmentally related groups as well as at environmental events in the state of Oklahoma; the final sample size was 270 respondents. We found that while participants were aware of the shifting causes of mortality of bird populations, they were less aware of the implications of wind energy on bat populations. In addition, attitudes towards biodiversity conservation as well as wind energy development were statistically significant when looking at how attitudes informed the identification of some impacts. Participants were also willing to support wind energy development if it had no impacts on biodiversity conservation, regardless of the trade-off presented. Attitudes towards biodiversity conservation were statistically significant in predicting almost all of these trade-offs. Lastly, various demographic factors such as gender and political affiliation were statistically significant when analyzing trade-off responses, but less demographic

variables were statistically significant when analyzed in the context of the presented attitude questions. Our research shows that environmentally conscious individuals are not well-informed on all impacts of wind energy development. The results also suggest that environmentally conscious individuals differ from the general public on what trade-offs they are willing to make to support wind energy development.

2.2 Introduction

Climate change and associated impacts comprise a central focus for environmental research, development and practical work today, with scientists seeking to understand the phenomena as well as propose innovations and alternative technologies mitigating its impacts. This work has generally fostered a desire to transition to more environmentally friendly practices in society. Environmental policy is often specified to either encourage environmentally friendly practices or to mitigate and discourage detrimental practices (Pitkanen et al, 2016). Biodiversity conservation and renewable energy development represent only two of many interests governed by environmental policy. Both policy efforts are incredibly important in their relationship to sustainable transitions, guiding adaptation to a changing climate. However, these efforts are often at odds with one another in terms of their goals and requirements for implementation (Swofford and Slattery, 2010).

Transitioning towards renewable energy sources is a prevalent theme in green economy initiatives globally. Wind energy often represents one pathway to meet renewable energy goals. Wind energy development throughout the 1990s and early 2000s was generally allowed to proceed without extensive research on environmental impact due in part to the perception that development did not carry a strong negative impact on the environment (UNEP, 2011). As wind farms continued to go into operation, issues arose surrounding the potential environmental impacts of wind energy development, including many related to biodiversity conservation. The "green on green" conflict moniker refers to prioritization conflicts between reduction in emissions of greenhouse gases from energy development and consumption and the prevention of environmental impacts associated with renewable energy development, including habitat loss, fragmentation, etc. (Swofford and Slattery, 2010; Devine-Wright, 2005). Jackson (2011) identifies this conflict between biodiversity conservation-related and renewable-energy related policies, characterizing renewable energy as a climate change mitigation strategy that may have negative impacts on biodiversity conservation.

Examining the other half of this "green on green" conflict, it's clear that biodiversity and related conservation issues are incredibly important for a variety of reasons. Biodiversity ensures long term supply of material goods, supports a multitude of ecosystem services, helps ecosystems remain resilient to natural disasters, and can be utilized for everyday recreational purposes (fishing, hunting, hiking, etc.). Biodiversity conservation faces numerous concurrent threats in society however, including increased proliferation of invasive species, habitat loss or fragmentation, overexploitation, and complications due to climate change (Rand et al., 2010). While renewable energy development can assist in alleviating the major pressures of overexploitation and climate change (UNEP, 2011), it can negatively impact biodiversity via pressures such as habitat loss or direct/indirect animal mortality (Loss et al., 2013).

While renewable energy is seen as an environmental sustainability initiative and green alternative to fossil fuels, complications affecting biodiversity concerns at wind energy production sites are evident. Not only can wind energy operations lead to direct animal mortality due to collisions with generators, it can also render adjacent habitat unsuitable for certain species sensitive to human disturbance. Biodiversity conservation efforts, conversely, can subject green economy activities to limitations on development via policy and lands protection practices. The juxtaposition of these two issues is prevalent in scientific literature, as seen in studies such as Bidwell (2013) and Swofford and Slattery (2010), both related to wind energy perception. Currently, however, there is a lack of research addressing and analyzing public opinion surrounding this conflict between two seemingly complementary initiatives constituent to an overall "green movement" or revolution.

The idea of the "green on green" conflict or debate was coined by Warren et al. (2005), terming it a "new kind of environmental controversy". While it seems to be standard that fossil fuel projects faced environmental opposition and a lack of support from environmental groups, it was often assumed that renewable energy developers would have the support of the environmental movement (Kahn, 2000). Kahn (2000, p.29), in describing the conflict between developers and environmentalists, says "decision makers expect environmental opposition to thermal power plants, but they are supposed to find wind, biomass, and geothermal projects under attack by erstwhile allies. No wonder environmentalists are more effective opposing renewables than fossil fuel power projects." While conflict between societal transitions and environmental impacts is not novel, this idea that there are valid "green" arguments on both sides is a more a recent development (Warren et al, 2005). Because of this, it is important that research not only examine public perceptions directly related to wind energy development but also more broadly examine perceptions of energy and the environment (Swofford and Slattery, 2010; Warren and Birnie, 2009).

This research seeks to combine this notion of the “green on green” conflict with work examining public perception in the realm of renewable energy. Research in the United States on attitudes towards wind farm development has mainly focused on capturing broad public perception. Researchers have utilized surveys covering a range of topics including economic impacts, visual impacts, environmental impacts, and other factors associated with the expression of negative attitudes in respondents. Research has identified attitudes and lack of public participation as main contributors to opposition of wind energy and some work also framed results as symptomatic of the “not-in-my-backyard” (NIMBY) dynamic. NIMBY, where applied to wind energy development, refers to the phenomenon of general support for wind energy, coupled with a lack of local support as turbines would be constructed in respondents’ “backyard” (Eiser and Jones, 2010). While the majority of research on NIMBY acknowledges this somewhat self-interested attitude is too simplistic to explain general opposition, the main conclusions point towards high economic expectations versus actuality (Fergen and Jacquet, 2016; Bidwell, 2013), visual aesthetics (Jones and Eiser, 2010; Groth and Vogt, 2014a,b; Swofford and Slattery, 2010; Kontogianni et al., 2014; Devine-Wright, 2005), and lack of opportunities for public participation (Groth and Vogt, 2014a,b; Swofford and Slattery, 2010; Devine-Wright, 2005) as drivers of attitudes towards wind energy development. Additionally, in general the literature on public opinion does not address perceptions of those who already self-identify as environmentally conscious (Rand and Hoen, 2017). Environmentally conscious individuals represent a unique group whose perceptions may indicate how views on green initiatives may change where faced with green versus green conflict. Researchers acknowledge the existence of this conflict (Swofford and Slattery, 2010; Devine-Wright, 2005) but there is no clear evidence that environmentally conscious individuals know and understand this conflict exists or represents a potential issue.

This research focuses on the state of Oklahoma, where turbine development has increased in recent decades. There currently exists literature based in Oklahoma on socioeconomic impacts of wind energy development (Greene and Geisken, 2013), impacts of wind development on public schools (Castleberry and Greene, 2017), the relationship of wind power and real estate prices (Castleberry and Greene, 2018), as well as a comparison of the impacts of wind energy and unconventional gas on land use and ecosystem services (Davis et al., 2018). At the time of this writing, however, virtually no representation of public opinion related to issues surrounding wind turbines in the state is seen in the literature. The one exception, Greene and Geisken (2013), performed in-person qualitative interviews of individuals as well as distributed a survey in their town of interest, Weatherford, Oklahoma. The interviews and surveys helped to supplement the economic analysis, in providing insight into how the community views the wind energy development. In addition, a Notice of Inquiry (NOI) was submitted to the Oklahoma Corporations Commission (OCC) and the Public Utilities Division (PUD) in 2014, requiring the OCC to investigate a series of questions regarding wind energy development in the state by surveying members of the public. Cited issues in the aforementioned survey included conflict with sacred/religious sites, costs of siting disputes, lack of participation by local governments or residents, and impacts on scenic highway byways. Greene and Geisken’s (2013) research and this NOI represent the only widely available reports exploring public perception with respect to wind energy developments in the state.

According to the US Energy Information Administration (2018), Oklahoma ranked third in the country in 2018 for electricity generation via wind energy. Maps of Oklahoma provided by the Office of Energy Efficiency and Renewable Energy through the U.S. Department of Energy (2015) show the highest wind speeds along with highest wind capacity (at 110 and 140 m. turbine hub height) in northwestern Oklahoma, within the panhandle of the state. The panhandle is the site of many proposed and existing wind farms in the state, but wind farm development can also be found throughout other areas in Oklahoma.

This study conducted a survey to specifically examine attitudes associated with the trade-off between biodiversity conservation and wind energy concerns among self-selecting, environmentally conscious individuals. As this is an intersection that prior research recognizes but does not directly address, the goal of this study is to add a new component to the literature by providing an avenue for further, related research efforts. Since public perception often informs or influences policy, it is important to understand opinion when looking to form new policies. This research seeks to explore public perceptions of environmentally conscious individuals towards wind energy in Oklahoma, with particular attention to awareness of specific green conflicts. Since environmentally conscious individuals may already be informed on environmental issues, but may not always realize the connection between them (e.g., whether this is a conflicting interest or where two issues can be solved with a comprehensive or unified approach), this sample group represents a unique avenue in which to examine the intersection of the two competing green interests of wind energy and biodiversity conservation.

2.3 Methods

2.3.1 Study area

Oklahoma is a leading state in wind energy production and hosts areas of high wind energy production potential relative to national averages (US EIA, 2018; US OEERE, 2015). Updated projections of wind resources in the South-Central Plains also implied stability of wind resources in the region for future wind energy generation (Wimhurst and Greene, 2019). Despite this, little work has been done to understand public opinion on wind energy development (eg. Greene and Geisken, 2013). Public policy as well as success in wind energy development can be hindered by prevailing negative attitudes, so it is important to understand perceptions within the state as development continues. This research involved administering a survey to self-selected, environmentally conscious individuals in the state of Oklahoma. The survey instrument specifically targets environmentally conscious people because they may already recognize biodiversity conservation and renewable energy as two important concepts related to climate change mitigation and adaptation but may not always realize how these two efforts can conflict. As this research focused largely on concerns related to public opinion regarding conflict among wind energy development and biodiversity conservation, more attention will be given to the environmental component.

2.3.2 Survey questions

The general focus of the survey is to understand where current knowledge of environmentally conscious individuals on environmental issues stands regarding the conflict between biodiversity conservation and wind energy development in the state of Oklahoma. The survey first asks how participants value renewable energy development and biodiversity conservation, respectively. Participants are then asked about their familiarity with eight impacts of wind energy development on biodiversity conservation; these specific impacts were identified in the literature review. Although the focus of this research is knowledge of environmental impacts, the survey also includes a set of questions meant to evaluate which broad impacts of wind energy development would negatively or positively impact participants' support for future energy development. Results from these questions could assist in providing a baseline to direct further research examining perceptions of wind energy development.

The online platform Qualtrics was utilized to create the survey and to distribute it online via an anonymous link. Distribution was accomplished by e-mail solicitation combined with requests for responses in-person. In-person events where the survey was administered included the Oklahoma Natural Resource Conference in February of 2019 as well as many events surrounding and held in recognition of Earth Day, April 2019. For the e-mail distribution, environmental organizations affiliated with the University of Oklahoma as well as non-university affiliated organizations were identified, and leaders were asked if they were willing to distribute the survey to their members. University-affiliated organizations included student organizations with an environmental focus and typically had memberships of 10 to 30. Non-university organizations included the Oklahoma chapters of both the Nature Conservancy and the Sierra Club. A social media event was also created to distribute the survey to members of participating organizations if internal organizational policy restricted distribution via e-mail listservs or equivalent alert systems.

2.3.3 Data analysis

The final sample size after removing incomplete responses was 270. Responses that were marked as incomplete (having less than a value of 100 in the associated column identifying a finished survey response) were removed. A value of 100 denotes that respondents participated in the survey until presentation of an end screen thanking them for their time – this result does not indicate respondents answered all questions, it only indicates the end of the survey was reached. Values less than 100 indicate that a respondent opted to leave the survey, and therefore their responses were removed from consideration. Typically, values less than 100 were also less than 50, indicating the respondent did not complete much of the survey during these attempts. If the response had a completion value of 100, response rate to demographic questions were then confirmed. If the participant failed to answer four or more of the questions, they were also removed from consideration for demographic summaries of participants. In addition, if the time taken to complete the survey was under 10 minutes, the responses were reviewed to ensure that a majority of the questions were completed, as the designed average time to take the survey was 15-20 minutes.

SAS (version 9.4) was used for all statistical analyses of the survey responses. All missing values were coded with "." to match SAS coding. After evaluating the distribution of demographic variables, race and income were re-categorized. Race was reduced from seven classes to two classes – white and non-white – as over 90% of respondents identified as white. Income was reduced from twelve classes to six classes. Intervals of $20,000 were used with a cut-off being $100,000 or above, with the income distribution being skewed enough to render the original $10,000 intervals having very few respondents in some cases. In addition, Likert scale questions were reduced to two or three categories instead of seven, based on the distribution of responses. For the research questions relating attitudes to knowledge as well as trade-off responses, the attitude questions were reduced to two categories. The highest category, “care very much”, had 60% of responses in regard to biodiversity conservation and 56% in regards to renewable energy development. Attitudes and trade-off responses compared to demographic factors were reduced to three categories after review. Both had a distribution that was spread out more above and below neutral for some of the categories, which is why they were left as categories of responses below neutral, neutral responses, and responses above neutral. Chi-squared tests as well as Fisher Exact tests were run on the responses, using both attitudes towards renewable energy and biodiversity conservation as well as demographic variables to evaluate statistical significance among various responses. Fisher Exact tests supported by a Monte Carlo simulation technique were utilized as a bootstrapping method where data violated the assumptions of Chi-squared tests and are noted as such. These tests were used to determine if attitudes or demographics impacted answers to knowledge-dependent questions and if demographics impacted the trade-offs respondents were willing accept, associated with wind energy development. For the knowledge-dependent questions included in the survey, summary statistics were prepared, as there is no definitive literature on the frequency with which the listed impacts happen and, therefore, there is no right or wrong answer assigned to the survey’s knowledge questions.

2.3.4 Sample characteristics

Participant age ranged from 18 to 82 years of age, with the average being 36 (median age is 31). 43% of respondents identified as male and 57% identified as female. 91% identified as white, with less than 1% identifying as black, 2% as American Indian, 2% as Asian, and 3% as Hispanic. 85% of respondents were residents of Oklahoma, with average years of residency being 21 years. Comparatively, according to the 2017 American Community Survey 5-year estimate by the U.S. Census Bureau, around 50% of the Oklahoma population is female and 50% is male. 73% of the population is white, 7% is black, 7% is American Indian, 2% is Asian, and 10% is Hispanic. The median age of the population reported by the ACS is 36.

40% of respondents were currently enrolled in an institute of higher education, and the majority of these respondents were working on a bachelor's degree (58%). Of those no longer enrolled in an institute of higher education, a majority held a 4-year degree or higher. 48% of respondents noted an affiliation with the Democratic party, while 13% were Republican, and 27% independent. On a scale of 1 to 7, 18% of respondents said they considered themselves more conservative (1-3) and 66% considered themselves more liberal (5-7); the median response of the data was 5. 77% of respondents said they did not live near a wind turbine, whereas 51% said they did live near a protected area. Sample demographic characteristics are available in Table 1.

Table 1. Demographic characteristics of the sample. (n=270)

Average age	36
Female	57% (n=151)
Male	43% (n=116)
White	91% (n=241)
Non-white	9% (n=29)
Average years of residency	21
Democrat	48% (n=128)
Republican	13% (n=35)
More conservative	18% (n=48)
More liberal	66% (n=177)
Live near wind turbines	19% (n=52)
Live near protected area	51% (n=136)

2.4 Results

2.4.1 Identified attitudes towards renewable energy and biodiversity conservation

Participants were asked to answer a series of questions related to their attitudes towards energy sources as well as biodiversity conservation. Tables 2 and 3 provide descriptive statistics for the responses to attitude-based questions. Given the results, most respondents agreed that fossil fuels negatively impacted the environment (a value of 1-3) and that renewable energy development positively impacted the environment (a value of 5-7). Examining how respondents felt renewable energy impacted wildlife conservation, a majority responded that it impacted it positively (a value of 5-7) but almost a third of respondents answered slightly negative (a value of 3). When looking at how much individuals cared about biodiversity conservation and renewable energy, participants cared very much about both, with a slightly higher percentage choosing the value "7" for biodiversity conservation (61% versus 56%).

Table 2. How participants felt specific energy sources impact the environment, presented as a percentage. (n=270)

"How do you feel…"	1 (Negatively)	2	3	4 (Does not impact)	5	6	7 (Positively)
Fossil fuels impact the environment?	64%	18%	13%	1%	1%	1%	2%
Renewable energy impacts the environment?	1%	2%	21%	6%	24%	19%	27%
Renewable energy impacts wildlife and wildlife conservation?	3%	6%	33%	5%	20%	18%	14%

Table 3. How much participants cared about biodiversity conservation and renewable energy development, presented as a percentage. (n=270)

"How much do you care about…"	1 (Don't care at all)	2	3	4 (Indifferent)	5	6	7 (Care very much)
Biodiversity conservation	0%	0%	0%	5%	12%	22%	61%
Renewable energy	0%	0%	0%	3%	16%	25%	56%

2.4.2 Can attitudes predict knowledge?

Participants were asked to identify whether or not certain statements about the impacts of wind energy development on biodiversity conservation were true or false. Table 4 presents descriptive statistics summarizing how many individuals thought each of the statements were true or false and how many individuals answered they did not know. Based on the results, a majority of respondents believe that wind turbines cause bird and bat mortality due to collision and that wind energy infrastructure construction leads to habitat fragmentation. A majority of respondents did not believe that wind energy development resulted in habitat unsuitable for species or that related activities lead to changes in local climate. For internal injury to bats as well as invasive species proliferation, responses were more variably distributed amongst the three response choices.

Table 4. Response numbers to impact questions, presented as a percentage. (n=270)

Knowledge questions – "Wind turbines cause"	True	False	Don't know
Bird mortality due to collision	79%	10%	11%
Bat mortality due to collisions	64%	14%	22%
Internal bat injury	43%	18%	39%
Unsuitable habitat	31%	51%	18%
Habitat fragmentation	64%	13%	23%
Erosion	21%	37%	42%
Invasive species proliferation	23%	37%	40%
Changes in local climate	22%	51%	27%

To evaluate the question "can attitudes towards renewable energy and biodiversity predict knowledge of the impact of wind energy development?", Likert scale responses related to attitudes were reduced to two categories, where "care very much" remained in a category on its own separate from the other Likert levels of response. A chi-squared statistical test was used for this analysis. The knowledge-based questions were not evaluated as being correct or incorrect, and the significance of attitudes with respect to their influence on knowledge-based responses is evaluated in terms of the impact's respondents noted as being true or false. This research was interested in understanding if particular attitudes informed the identification of impacts versus the objective truth or falsehood in responses. Attitudes toward renewable energy development were statistically significant at the 90% confidence level for answers related to bat collisions with turbines ($p = 0.0718$) as well as changes in local climate due to wind turbine development ($p = 0.0522$). Attitudes towards biodiversity conservation were statistically significant at the 95% confidence level in predicting answers to knowledge questions pertaining to development rendering habitat unsuitable for species ($p = 0.0165$) as well as causing fragmentation of habitat ($p = 0.0228$). In addition, attitude toward biodiversity conservation was also statistically significant at the 90% confidence level in predicting answers to the knowledge question pertaining to internal injuries to bats as well as when determining what participants identified as the leading cause of bird mortality ($p=0.0952$) (Table 5).

Table 5. Do attitudes predict knowledge? Evaluating how attitudes towards biodiversity conservation and wind energy development impact what individuals perceive as impacts to biodiversity conservation.

Knowledge questions[a]	"How much do you care about…" p-value[b]	
	Biodiversity conservation	Renewable energy
Bird collision	NS	NS
Bat collisions	NS	0.0718*
Internal bat injury	0.0719*	NS
Unsuitable habitat	0.0165**	NS
Fragmentation	0.0228**	NS
Erosion	NS	NS
Invasive species	NS	NS
Changes in climate	NS	0.0522*
Leading cause of bird mortality	0.0952*	NS
Leading cause of bat mortality	NS	NS

[a]Knowledge questions were presented with answer options "true", "false", or "don't know"
[b]p-values correspond to a chi-squared test.
*Significant at 0.1 **Significant at 0.05 ***Significant at 0.01

2.4.3 Perceived leading causes of bird and bat mortality

Figure 1 shows the leading cause of bird mortality as identified by participants. Almost 45% of individuals believe that cats are the leading cause of bird mortality, followed by collision with buildings at just under 25%. Wind turbines were the least identified leading cause of mortality, with less than 5% of respondents.

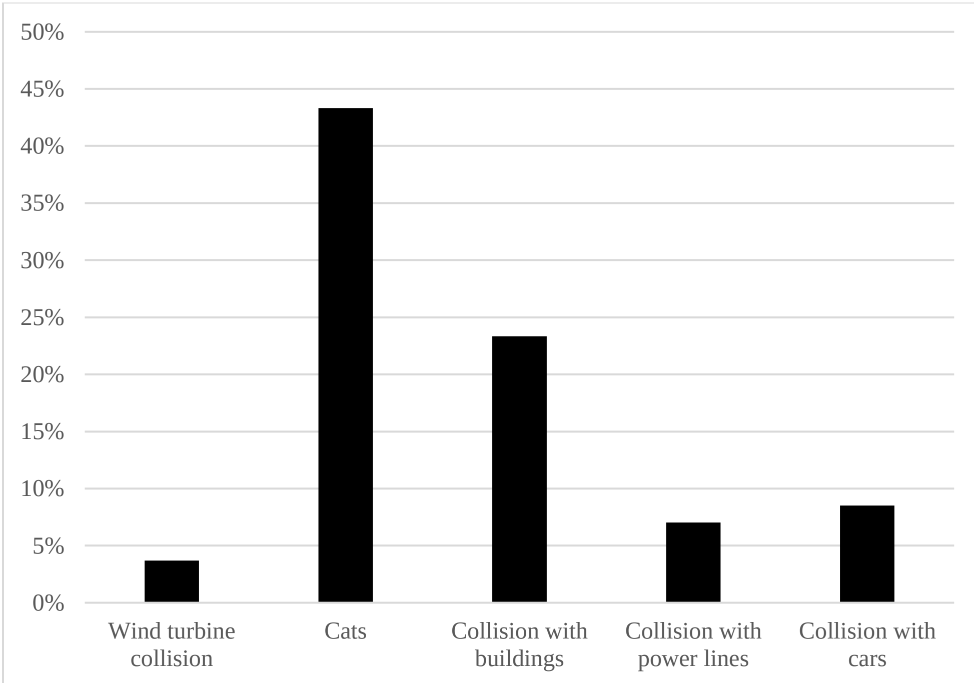

Figure 1. What do you think is the leading cause of bird mortality? Participants identified what they believed to be the leading cause of mortality from the list of potential causes provided.

Figure 2 shows the identified leading cause of bat mortality by participants. Almost 50% of individuals believe that disease – specifically white nose syndrome, as noted in the survey – is the leading cause of bat mortality, following by almost 30% who responded they did not know. Wind turbines were again the least identified leading cause of mortality, with less than 5% of respondents.

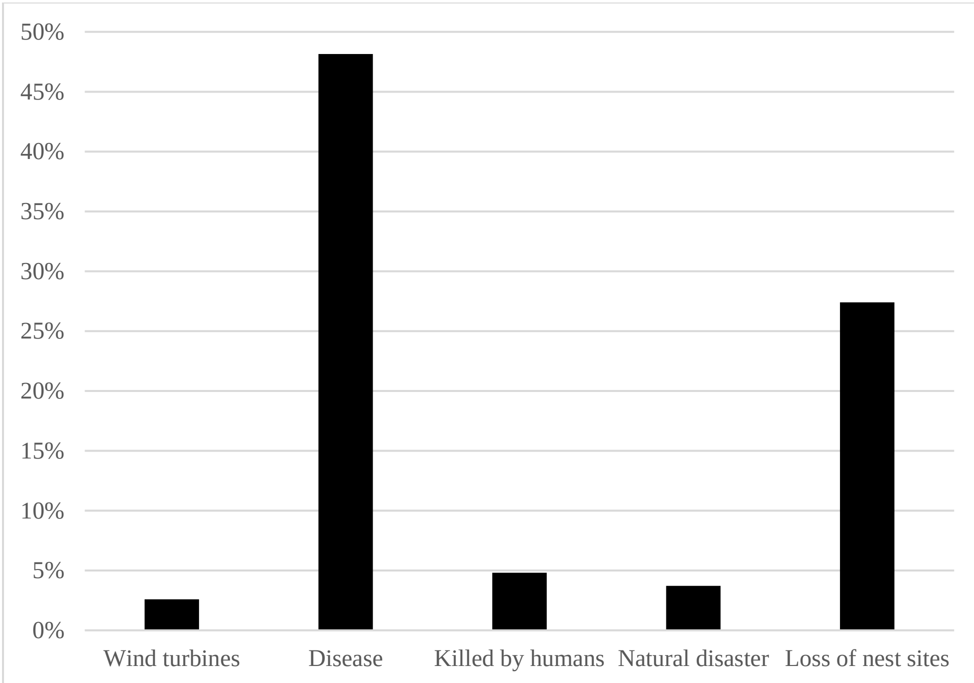

Figure 2. What do you think is the leading cause of bat mortality? Participants identified what they believed to be the leading cause of mortality from the list of potential causes provided.

2.4.4 Can attitudes predict trade-offs?

Participants were asked whether they'd be more or less willing to support wind energy development given certain trade-offs between biodiversity conservation and other impacts of wind energy development. Table 6 presents descriptive statistics of how many individuals responded to each level of support for the given trade-offs. Based on the results, a majority of respondents would be opposed to development of wind energy (selecting a value of 1-3) if it had a negative impact on biodiversity in any of the trade-offs presented. A majority of respondents would be supportive (selecting a value of 5-7), however, of wind energy development if it did not impact biodiversity, even if it resulted in negative impacts on the integrity of the landscape or resulted in higher energy prices. In addition, a majority of respondents would be supportive (selecting a value of 5-7) of wind energy development near their home, with a third of respondents identifying that they would be very supportive.

Table 6. Response numbers to trade-off questions in terms of support or opposition to development of wind energy, as a percentage. (n=270)

Questions about trade-offs of wind energy development[a]	1 (Very opposed)	2	3	4 (Neutral)	5	6	7 (Very supportive)
Fewer impacts on biodiversity Negative impacts on integrity of the landscape	4%	4%	15%	15%	20%	22%	19%
Negative impacts on biodiversity No impacts to human health	9%	21%	27%	12%	18%	7%	6%
Negative impacts on biodiversity Leads to economic growth and opportunity	6.0%	20%	31%	11%	25%	5%	2%
Negative impacts on biodiversity Includes public participation and opinion	7%	18%	29%	18%	21%	6%	2%
No impact on biodiversity Higher energy costs	3%	5%	12%	10%	28%	22%	21%
Negative impacts on biodiversity Locally accessible energy	7%	19%	32%	13%	20%	6%	3%
Would you support wind energy near your home?	6%	3%	6%	14%	19%	17%	34%

Evaluating the question “can attitudes towards renewable energy and biodiversity predict trade-offs of wind energy development?”, Likert scale responses related to attitudes were reduced to two categories, where “care very much” remained in a category on its own. A chi-squared statistical test was used for this analysis. Based on the results, biodiversity conservation was statistically significant in determining support for all of the listed trade-offs except for "positively impacting biodiversity but negatively impacting the natural integrity of the landscape". Biodiversity conservation was statistically significant at the 99% confidence level, except for "negatively impacts biodiversity but positively impacts economic development in your community" and "supporting wind energy development near your home", which were statistically significant at the 95% confidence level. In addition, renewable energy was statistically significant in determining support for the following trade-offs: "a positive impact on biodiversity but negative impacts on the natural integrity of the landscape" ($p = 0.0019$) and "a positive impact on biodiversity but higher energy costs" ($p < 0.0001$). Attitudes towards renewable energy were also statistically significant in impacting support for having wind energy development near the homes of respondents ($p < 0.0001$) (Table 7).

Table 7. Can attitudes predict trade-offs? Evaluating how attitudes towards biodiversity conservation and wind energy development impact what trade-offs individuals are willing to make when supporting wind energy development.

Questions about trade-offs of wind energy development[a]	"How much do you care about…" p-value[b]	
	Biodiversity conservation	Renewable energy
Fewer impacts on biodiversity Negative impacts on integrity of the landscape	NS	0.0019***
Negative impacts on biodiversity No impacts to human health	0.0014***	NS
Negative impacts on biodiversity Leads to economic growth and opportunity	0.0154**	NS
Negative impacts on biodiversity Includes public participation and opinion	0.0002***	NS
Fewer impacts on biodiversity Higher energy costs	<0.0001***	<0.0001***
Negative impacts on biodiversity Locally accessible energy	0.0006***	NS
Would you support wind energy near your home?	0.0128**	<0.0001***

[a]Trade-off questions were presented on a scale of 1-7 from "very opposed to development" to "very supportive of development"
[b]p-values correspond with a chi-squared test.
*Significant at 0.1 **Significant at 0.05 ***Significant at 0.01

2.4.5 Demographic characteristics and trade-off responses

Evaluating the relationship between demographic variables and support for development based on various trade-offs, there were six trade-offs introduced in the survey for participants to consider as well as an additional question about support for wind development near their home, and the resulting significant demographic variables for each question are presented in Table 8. Gender, race, political affiliation, and whether individuals considered themselves more liberal or conservative were all statistically significant in at least half of the trade-off scenarios presented. Whether individuals were an Oklahoma resident or not as well as demographic variables related to education and if individuals lived near a protected area were significant for only one scenario or none of the scenarios.

Table 8. Demographic characteristics and trade-offs.

Questions about trade-offs of wind energy development[a]	Demographics p-value[b,c]											
	Age	Gender	Race	OK resident	Currently attending institute of higher edu.?	If yes, what degree?	If no, highest level of edu.?	Income	Political affiliation	More conservative or liberal?	Live near wind turbines?	Live near protected area?
Positive impacts on biodiversity Negative impacts on integrity of the landscape	NS	0.0208**	0.0835*	NS	NS	NS	NS	NS	0.0176**	0.0010***	NS	NS
Negative impacts on biodiversity No impacts to human health	0.0088***	0.0494**	0.0067***	NS	0.0103**	0.0653*	NS	0.0897*	0.0291**	NS	0.0649*	NS
Negative impacts on biodiversity Leads to economic growth and opportunity	NS	0.0023***	NS	NS	NS	0.0186**	NS	0.0518*	NS	NS	NS	NS
Negative impacts on biodiversity Includes public participation and opinion	0.0550*	0.0662*	0.0487**	NS	NS	NS	NS	0.0851*	0.0087***	0.0882*	0.0171**	NS
Positive impacts on biodiversity Higher energy costs	NS	0.0566*	NS	NS	NS	NS	NS	NS	0.0009***	<0.0001***	NS	NS
Negative impacts on biodiversity Locally accessible energy	NS	0.0950*	0.0023***	NS	NS	NS	NS	NS	0.0194**	NS	NS	NS
Would you support wind energy near your home?	0.0283**	NS	NS	0.0906*	NS	NS	NS	NS	0.0080***	0.0038***	NS	0.0101**

[a]Trade-off questions were presented on a scale of 1-7 from "very opposed to development" to "very supportive of development"
[b]NS = not significant *Significant at 0.1 **Significant at 0.05 ***Significant at 0.01
[c]p-value corresponds to a Fisher Exact test with simulation because of violation of assumptions if a chi-squared test was applied.

2.4.6. Demographics and attitude questions.

For evaluating the relationship between demographic variables and various questions about attitudes toward energy production and the environment, there were three questions related to attitudes towards impacts and two questions broadly gauging attitudes towards the two topics of this research, and the resulting significant demographic variables for each attitude question are presented in Table 9. Overall, fewer demographic variables were significant in predicting attitude versus predicting trade-off support or opposition. Only whether individuals considered themselves more liberal or conservative was significant for a majority of questions, while four variables were significant for none of the questions.

Table 9. Demographic characteristics and attitudes.

Questions related to attitudes[a,b]	Demographics p-value[c,d]											
	Age	Gender	Race	OK resident	Currently attending institute of higher edu.?	If yes, what degree?	If no, highest level of edu.?	Income	Political affiliation	More conservative or liberal?	Live near wind turbines?	Live near protected area?
How do you feel fossil fuels impact the environment?	NS	0.0034***	NS	NS	NS	NS	NS	0.0092***	0.0018***	0.0071***	0.0963*	NS
How do you feel renewable energy impacts the environ.?	NS	NS	NS	0.0375**	0.0714*	NS	NS	NS	NS	NS	NS	NS
How do you feel that renewable energy impacts wildlife and wildlife conservation?	NS	NS	NS	0.0366**	0.0192***	NS	NS	NS	NS	NS	NS	NS
How much do you care about biodiversity conservation?	NS	NS	NS	NS	NS	NS	0.0662*	NS	NS	0.0104**	NS	NS
How much do you care about renewable energy development?	NS	0.0305**	NS	NS	NS	NS	NS	NS	0.0018***	0.0127**	0.0034***	NS

[a]Impact questions were presented from "negatively" to "positively"
[b]Attitude questions were presented from "do not care at all" to "care very much"
[c]NS = not significant *Significant at 0.1 **Significant at 0.05 ***Significant at 0.01
[d]p-value corresponds to a Fisher Exact test with simulation because of violation of assumptions if a chi-squared test was applied.

2.5 Discussion

2.5.1 Attitudes and participant knowledge of impacts

Energy development and biodiversity conservation may have an influence on what participants felt were notable impacts associated with renewable energy development. The list of possible impacts was derived from a literature review of studies examining the intersections of renewable energy development and the environment, including bird mortality (Marques et al., 2014; Loss et al., 2013a; Kunz et al., 2007; Dai et al., 2005), bat mortality (Frick et al., 2017; Kunz et al., 2007; Dai et al., 2005), making habitat unsuitable for certain species (Dai et al., 2005; Winder et al., 2015; Winder et al., 2014a,b), habitat fragmentation (Gasparatos et al., 2013; Dai et al., 2005; Kuvlesky et al., 2007), soil erosion (Dai et al., 2005; Álvarez-Farizo and Hanley, 2002), proliferation of invasive species (Gasparatos et al., 2013), and changes in local climate (Dai et al., 2005; Leung and Yang, 2012). This literature represented a broad scope of possible impacts identified by these researchers. Given that not every impact listed represents a cause-effect consensus on wind energy development in the literature – such as proliferation of invasive species or changes in local climate – this research did not seek to evaluate statistical significance of correct or incorrect answers, but was instead interested in whether feelings towards the two topics affected what impacts they identified as true versus false or that respondents maintained they did not know.

While literature exists on perceptions of wind energy development (such as Groth and Vogt, 2014a,b; Olson-Hazboun et al. 2016) as well as review literature on the state of knowledge about impacts of wind energy development (Kumar et al., 2016; Dai et al., 2015; Leung and Yang, 2012), evaluations concerned with what the general public knows about impacts does not exist. The present research provides a novel evaluation of this concept, starting with a survey-based study examining the opinions of environmentally conscious individuals. As this group may be actively seeking out information related to renewable energy topics, they represent a unique opportunity to see what information may be available for individuals to access on this topic. As there is not much evidence available in literature to compare against our results, the following discussion offers an evaluation of results pursuant to an understanding of green conflict opinion among the environmentally conscious, and potential avenues for future research.

Reviewing the summary statistics drawn from respondents' answers in Table 4, most participants were aware that bird mortality due to collision with wind infrastructure was indeed an impact of renewable energy development. This is not surprising, as there has been a multitude of news stories related to bird mortality due to turbines. Studies have been published on the impacts of the Altamont Wind Pass farm in California as early as the late 1980's (such as Thayer and Freeman's study of perception published in 1987); the bird mortalities related to Altamont were relatively high, as Altamont was one of the first large wind farms in the U.S. While almost 80% of individuals did recognize that collision was a cause of bird mortality, less than 5% of individuals identified it as the leading cause of bird mortality (Figure 1). Collision mortality was identified as the leading cause the least often among respondents, which corresponds with the U.S. Fish and Wildlife listing of the leading causes of bird mortality (USFWS, 2018). It is also an interesting result to note, that almost 45% of respondents identified cats as the leading cause of bird mortality, which is correct based on current estimates. This high number of respondents selecting cats as the leading mortality cause could be attributed to recent news coverage in the past few years about the number of birds likely killed by domestic cats, spurred by Loss et al.'s publication (2013b) on the impact of domestic cats on birds.

A majority of individuals recognized that bat mortality can also be caused by collisions with wind turbines. While respondents were aware of the collision component, less respondents were aware of the internal injury to bats (barotrauma, where the mechanism of injury is a pressure differential along turbine blades) that can be caused by turbines, as 39% said they did not know. This was not surprising, as the discovery of barotrauma is more recent in comparison to studies of collision of both birds and bats. Considering what individuals chose as the leading cause of bat mortality, almost 50% of respondents identified disease (notated as white nose syndrome in the survey) (Figure 2). Wind turbines were identified least often as the leading cause, which contrasts with empirical understandings of the barotrauma phenomena, unlike with bird mortality. Based on recent studies, wind turbine related mortalities have the potential to negatively impact population stability of certain bat species (Frick et al., 2017). According to an article posted by the Wildlife Society in 2016, white nose syndrome and wind turbine related mortalities are the leading causes of bat mortality (Learn, 2016). Based on this finding, it seems there may be a lack of dissemination of information about the consequences of wind turbine development on bat populations, as participants in this survey recognized that wind turbines impacted bats but did not identify it very often as a leading cause of mortality.

While bird and bat mortalities are the two most frequently cited impacts of wind energy development, there are other potential impacts identified in the literature that were also presented to participants. A majority of respondents said that wind energy development did not make habitat unsuitable for species. This question was related to recent studies about the impacts of turbine development on prairie chicken species in the region, which indicate that the turbine development may promote avoidance behavior and impact reproductive success (Mcnew et al., 2014; Winder et al, 2014a,b; Winder et al., 2015). A majority of respondents did agree that wind energy development can lead to habitat fragmentation; while not directly connected, this could relate to the general perception that wind farms impact the integrity of the landscape (Groth and Vogt 2014a,b; Fergen and Jacquet, 2016). With respect to increased erosion/disturbance of drainage dynamics and invasive species proliferation, respondents' answers were more variably distributed with no clear consensus among participants, a finding aligned with a lack of treatment in the literature on these impacts. Lastly, a majority of participants said that wind energy development does not lead to changes in local climate, which is another impact that has not been studied in-depth.

When looking at which knowledge questions and attitudes had a statistically significant impact on responses, how much individuals cared about biodiversity conservation was statistically significant ($\alpha = 0.05$) in predicting how people responded to questions related to unsuitable habitat and habitat fragmentation. Attitudes towards biodiversity conservation were statistically significant ($\alpha = 0.10$) on responses to questions related to internal bat injury as well as what respondents identified as the leading cause of bird mortality. In general, an individual's attitude towards biodiversity conservation most likely influences what they know about the current threats to species in their region of interest. This, for example, could have led individuals to be more familiar with research that exists on habitat suitability and fragmentation, potentially in relation to the lesser prairie chicken in Oklahoma, and this may have impacted how they responded. In comparison, the level of how much individuals cared about renewable energy was statistically significant ($\alpha = 0.10$) in predicting how individuals responded to questions related to bat collisions and changes in local climate. These individuals may have been more exposed to how wind farms operate if they cared more about wind energy than biodiversity conservation. The statistical significance, however, could arise from individuals caring less about wind energy development; they therefore may have had less exposure to information about existing impacts.

These results emphasize the difference that exists in what environmentally conscious individuals know about the impacts of renewable energy development, particularly when it comes to the impacts on bat populations. Our results indicate that a gap in dissemination of information about all impacts of wind energy development. While many individuals no longer believe that wind turbines cause high amounts of bird mortality when compared to other causes, there is less known about the potential impact of wind turbine development on bat population success. Future research could include further analysis of the existing news on these impacts as well as new or future developments, both in impacts to biodiversity as well as potential mitigation solutions. Approaches from sentiment analytics (Pak and Paroubek, 2010) could find utility in examining Twitter tweets and other social media data streams related to information sharing and opinion leadership on renewable energy development. A textual analysis framework could provide context to these knowledge questions, by quantifying what news and resources are currently available for individuals. This analysis could help to provide context regarding the present gap in knowledge and assist further in disseminating information.

2.5.2 Attitudes and willingness to support wind energy development based on trade-offs

The trade-offs section of the survey instrument provided participants with a series of questions soliciting their valuation of sustainable energy and sustained biodiversity respectively, to assist in evaluating what individuals would be willing to allow to happen insofar as they support wind energy development. The trade-offs presented in this component of the survey were drawn from a literature review of research on public perception; perceived negative impacts were then paired with the goals of biodiversity conservation (Álvarez-Farizo and Hanley, 2002; Devine-Wright, 2005; Enevoldsen and Sovacool, 2016; Groth and Vogt, 2014a,b; Jones and Eiser, 2010; Kontogianni et al., 2014; Olson-Hazboun et al., 2016; Swofford and Slattery, 2010). Here, we compare the results of trade-offs responses to themes present in the literature, to help frame under what circumstances environmentally conscious individuals would support wind energy development given their ambient (or perhaps direct) exposure to elements of public opposition to development.

First, with respect to the summarized responses to trade-off questions (Table 6), an overall trend is evident in what scenarios participants would be willing to support or would oppose and the implications of that scenario on biodiversity conservation (no impact or negative impact). A majority of respondents indicated they would be opposed to development of wind energy if it had any sort of negative impact on biodiversity. These responses included the following trade-offs, as they were worded in the original survey: lack of impacts to human health, economic growth and opportunity, public participation and inclusion in the process, and locally accessible energy. All of these trade-offs were listed complaints related to wind energy development identified in the literature, so it is interesting that, despite this, environmentally conscious respondents were willing to sacrifice certain components such as economic growth or locally accessible energy if it meant there would be no impacts to biodiversity. Conversely, the majority of respondents indicated they would be willing to support wind energy development if it had fewer impacts on biodiversity, regardless of the associated trade-off. The related trade-offs for these questions were negative impacts on the integrity of the natural landscape and higher energy costs, which were again listed as complaints in literature concerned with public perception of wind energy. The summarized responses to trade-off questions indicate a potential trend in support among environmentally conscious individuals for wind energy development, provided it does not impact biodiversity. Additionally, opposition to wind energy development would be observed if negative impacts to biodiversity are evidenced. Lastly, respondents were asked if they would be supportive of wind energy near their homes, and the majority indicated they would be supportive. A third of respondents even indicated they would be very supportive of development (Table 6). Despite the possibility of increased knowledge about the impacts of wind energy development within this group of environmentally conscious individuals, 70% would support, to some extent, development near their homes.

The main goal of this portion of the survey was to assess whether attitudes towards renewable energy development and biodiversity conservation could predict types of trade-offs environmentally conscious individuals would be willing to accept. Ultimately, biodiversity conservation was statistically significant in predicting all the responses to the trade-off questions, except for the very first trade-off presented, where there would be fewer impacts on biodiversity but negative impacts on the integrity of the natural landscape. The influence of how much individuals cared about biodiversity conservation aligns with the trend seen in the summarized responses of the trade-off section. There was a clear delineation in support or opposition based on what type of impact biodiversity would experience (no impact or a negative impact). When looking at how much individuals cared about renewable energy development and the trade-offs, it was statistically significant in predicting acceptance among three of the trade-offs presented; fewer impacts on biodiversity but negative impacts on the integrity of the landscape, positive impacts on biodiversity but higher energy costs, and whether or not individuals would be willing to support development near their home. While this bivariate analysis does not indicate in what direction, pro or against, attitudes toward renewable energy impacted trade-off responses, it is of interest that attitudes only impact the two trade-offs having fewer impacts on biodiversity. It could be that the respondents who care about renewable energy also recognize the impacts it currently has and are willing to support developments more if those impacts were to be eliminated. When looking at the trade-off that would result in higher energy costs, for some individuals, wind farms are actually viewed as a modern and tangible sign of transition to an environmentally friendly future (Fergen and Jacquet, 2016). Viewed this way, environmentally conscious individuals may be willing to pay more or accept harsher trade-offs as wind energy represents a major option in the shift away from a fossil fuel intensive economy.

The results of this section suggest that for environmentally conscious individuals, the impacts of wind energy development on surrounding ecosystems is more important than factors such as economic development and human health impacts. This contradicts what is present in some of the literature on public perception of wind energy development, which focuses on complaints related to impacts on human health (Fergen and Jacquet, 2016; Kumar et al., 2016) and the integrity of the natural landscape (Jones and Eiser, 2010; Groth and Vogt, 2014a,b; Swofford and Slattery, 2010; Kontogianni et al., 2014; Devine-Wright, 2005) versus the implications for biodiversity conservation. It is interesting that participants appeared to care more about biodiversity conservation versus other impacts, which may already exist in the state and have been experienced by individuals. For example, as shown by Greene and Geisken (2013) via economic modeling, their community of interest experienced a significant economic impact due to wind farm construction and they cite the potential for additional income in terms of economic growth and jobs in Oklahoma. In addition, research has suggested that wind power development could help stabilize school funding in the face of changing state and federal education funding (Castleberry and Greene, 2017). These are just two examples of the benefits Oklahoma has seen due to wind energy development, but our survey suggests individuals may be willing to sacrifice these benefits if it means biodiversity will be negatively impacted.

It would be valuable to extend this survey to environmentally conscious individuals in other states or regions, to evaluate if this finding still stands in a broader population of participants. In addition, future research could expand on this by including a qualitative component in which individuals in communities that have wind farms nearby as well as communities that do not are administered extended or free-response interviews. This would allow a comparative analysis of experience versus perceived trade-offs, to add context to what support or opposition really means for awareness in this arena.

2.5.3 How do demographics interact with trade-off support or opposition and attitudes?

Rand and Hoen (2017) indicate in their review of the existing research on wind acceptance studies that demographic variables are not often found to be statistically significant in their influence on variation in attitudes and beliefs towards wind energy development. Groth and Vogt (2014a) found, in analyzing the results of their 221 respondents, that demographic variables such as age, gender, amount of time living in the county, and distance from turbines were not correlated with expressed perceptions; only land ownership contributed significantly to their findings. Bidwell (2013) found that education influenced responses to the “wind caution” and that gender was marginally significant for traits such as “wind enthusiasm” and “wind caution”, with 375 completed surveys. Olson-Hazboun et al. (2016) had a sample size of 906 and found that only gender had a significant impact on general renewable energy attitudes in the final model. When looking at local wind energy attitudes, they found that being older and more liberal had an initial relationship with the outcomes, but this relationship diminished with additional modeling. In the final model, they found that more highly educated individuals were more likely to support development. Jacquet and Stedman (2013), with a sample size of 1,028 found weak correlation of age and education with wind farm attitude as well as with wind farm impacts. Lastly, Firestone et al. (2015), who had a sample size of 458, evaluated a set of demographic variables and whether participants were agreeable to the look of turbines, and found no statistically significant differences among them. In context with these findings in the literature, we seek to outline the lack of relationship between demographic variables and various components of wind energy attitudes in previous research. Demographic variables should not be discounted as attitudes towards wind energy development, but rather, are understood to represent a complex set of interactions and can be highly context specific.

Given the results in Tables 8 and 9, our research suggests that, among the demographic variables, gender is statistically significant where analyzing the trade-offs individuals were willing to make. The only survey question statistically significantly affected by gender asked participants if they would be willing to support wind energy development. Gender, however, was not statistically significant when evaluating any of the attitude questions included in the survey. This aligns with findings outlined from the literature, where both Bidwell (2013) and Olson-

Hazboun et al. (2016) found gender played a role in some of their analysis, but sometimes only a marginally significant role. In addition, political affiliation as well as whether participants considered themselves more conservative or liberal was statistically significant in predicting responses to a majority of the trade-off questions. These two variables were also highly statistically significant considering how participants felt fossil fuels impacted the environment as well as when asked how much they cared about renewable energy development. These demographic variables were not always explicitly included in prior research efforts but could be related to questions asked about participation in the planning process and the role of local government (Olson-Hazboun et al., 2016; Kontogianni et al., 2014; Groth and Vogt, 2014b). Level of education played a significant role in some responses, including how individuals felt renewable energy development impacted wildlife conservation, but were weakly significant in line with results from prior research (Bidwell, 2013; Olson-Hazboun et al. 2016; Jacquet and Stedman, 2013).

In comparison to the analysis of trade-off responses and demographics, relatively few demographic variables had statistical significance in predicting attitude responses. This confirms what Rand and Hoen (2017) suggest in their review, although our research found 14 significant relationships among the 60 possible relationships of participant responses and demographics. As these results are characteristic of a more specific group of individuals (self-selecting environmentally conscious individuals) versus surveying the general population, there may be some uniformity among individuals' expressed opinions and their demography. Because the spread of demographic variables responses may not be quite as diverse as would be expected in the general public, this could also explain why more demographic variables presented as statistically significant in our study versus in other studies. As the questions and scale of respondents also differ from other research, this may also have had an impact on our results compared to other studies.

2.6 Conclusion

This research found that environmentally conscious individuals were aware of the various impacts of renewable energy development on biodiversity conservation, and that while they recognized turbines are not the leading cause of bird mortality, participants appeared to not know as much about the impacts of turbine development on bats. Participants were willing to support wind energy development projects that did not impact biodiversity and were not willing to support any wind energy development projects that negatively impacted biodiversity. In addition, attitudes towards biodiversity conservation were statistically significant in predicting in almost all of the trade-off questions, which could be why there was a strong trend presented in when individuals would and would not be willing to support wind energy development. Lastly, while previous research related to wind energy attitudes has found demographic variables largely not significant in determining attitudes, this research found that some demographic variables, including gender, political affiliation, and whether individuals identified as more liberal or conservative, were statistically significant for questions related to trade-offs as well as general attitude questions. This finding could indicate that, in certain scenarios, demographic variables may be part of the complex set of factors creating the context for attitudes to develop, with respect to societal transition strategies including as renewable energy development.

Future research could extend this survey to the general public, to serve as a comparison between how environmentally conscious individuals responded versus the public. If a difference does exist, studying why differences present themselves could help to determine how environmental innovation is presented to the public. As our research showed, there is a lack of knowledge within this participant group of environmentally conscious individuals in regard to the impacts of wind energy development on bats. This lends itself to the question of why this gap exists. An in-depth analysis of how environmentally conscious individuals obtain their information versus how the general public do could provide insight into the best ways for local governments and developers to approach community engagement projects. The trade-offs component of this survey, in addition, provides some context describing under what circumstances wind energy development is acceptable; it would be important to see how the general public values the various components inherent to wind energy development versus environmentally conscious individuals, especially as the environmentally conscious appear to value biodiversity conservation over all else. It is possible that environmentally conscious individuals have a different conception of sustainability as a concept and are more focused on the environmental component, whereas the general public may be more concerned with the economic and social implications as well. Overall, this research provides additional context from which to analyze wind energy attitudes by further defining the notion of a "green on green" conflict. We asked respondents to identify what they knew about the implications of this conflict via the knowledge questions and specifically framed the trade-off component in terms of biodiversity conservation versus the other potential costs or benefits of wind energy development. By focusing on environmentally conscious individuals, we confronted the paradox described by both Warren et al. (2005) as well as Kahn (2000), in that there is an expectation that environmentalists will be proponents of wind energy development but that is often not the case.

As society continues to transition towards greener practices, it will be important to expand our understanding surrounding what individuals perceive as viable impact trade-offs for these practices.

Chapter 3: Conclusion

3.1 Extended Discussion

The “green on green” conflict, as coined by Warren et al. (2005), represents a valuable lens through which to examine public knowledge and perception of wind energy development. As both sides of the debate are based on sound environmental arguments, it is important to understand what individuals know and what information is made available when this conflict arises. This research worked to examine the knowledge of this conflict among environmentally conscious individuals in Oklahoma. In general, the literature on public perception of wind energy development has not specifically looked at environmentally conscious individuals, who provide a unique lens for which to evaluate this conflict through.

In my second chapter, I described a survey conducted utilizing this “green on green” conflict lens to understand what environmentally conscious individuals in Oklahoma know about the impacts of wind energy development on biodiversity conservation. I found that there were still some gaps in the knowledge about impacts of wind energy development, specifically around impacts on bat populations. In addition, I found a relationship between how wind energy development could impact biodiversity conservation and the support or opposition respondents selected related to future development. Lastly, I found some relationships between demographic variables and trade-off responses as well as general attitude.

Because perceptions and attitudes related to wind energy development and biodiversity conservation are context specific, I wanted to also briefly touch on the trend in my results that there appeared to be more concern related to biodiversity conservation versus interest in wind energy development. While there is not much literature to support this trend, it is important to highlight the potential contextual causes of this trend within the state of Oklahoma. While wind energy development is prominent in the state, government entities such as the Oklahoma Department of Wildlife Conservation and non-profits such as The Nature Conservancy, also have very strong discourse related to biodiversity conservation projects in the state. This includes conservation projects in the ecosystems within the Great Plains region , which include many species of interest such as the sage grouse, prairie chicken, and pronghorn. A portion of my final sample for this research project included individuals who are likely involved in biodiversity conservation projects, and this could have contributed towards the prominence of biodiversity conservation in perception of wind energy development. My experience collecting data for the survey and also interacting with individuals in both the conservation and renewable energy development field has shown that, in the state of Oklahoma, biodiversity conservation often appears to take precedence.

This research contributes to a growing body of literature that addresses the social systems within sustainability and societal transitions (Gliedt and Larson, 2018). The questions within this survey include components of all three pillars of sustainability (social, environmental, and economic) and begin to address which of these pillars are prioritized by individuals when considering support or opposition of wind energy development. In addition, I emphasize that conflicting priorities can arise during societal transition, via the idea of the “green on green” conflict. While trade-offs in sustainability are often visualized via the balance between the environmental and economic pillars of sustainability (Hahn et al., 2010), it is important to recognize the balancing act between all three pillars that often occurs. Analyzing the conflict between wind energy development and biodiversity conservation by utilizing public perception research allows for all three pillars to be evaluated, versus focusing on only one or two.

3.2 Study Limitations

This work utilized only bivariate statistical methods for the analyses, as that is the extent of my statistical knowledge at this point in my academic career. Based on an examination of the literature, it is not uncommon to see bivariate analyses in research related to public perception. Future research and analyses of this project could include an extended multivariate analysis of all components. A multivariate analysis could answer questions related to how much or how little individuals cared about renewable energy development or biodiversity conservation and how that impacted which impacts they identified as true or false or did not know. A multivariate analysis could also provide insight into exactly how attitudes impact support or opposition and in what direction. This will be performed in future work, when I have learned the appropriate methodology in future coursework.

In addition, my sampling technique for reaching environmentally conscious individuals could have potentially introduced bias into my results. When trying to reach environmentally conscious individuals, I distributed my survey to any organization that had an environmental theme, both university-affiliated and non-university affiliated. There may be, however, additional groups of individuals that do not participate in these organizations but still consider themselves environmentally conscious. In addition, members of the Oklahoma chapter of The Nature Conservancy could only be reached via a Facebook post, as their current policies prohibit soliciting their members for other organizations' interests. This may have limited how many members of the organization participated, as not all members of the state chapter may have access or regularly use social media. While there are frequent challenges in sampling and survey distribution, I do feel that I was able to capture a representative sample of environmentally conscious individuals. Distribution techniques beyond email solicitation, including Amazon Mechanical Turk and other online survey distribution platforms, could have assisted in including more respondents. Using these platforms would have required utilizing additional qualifier questions to capture responses of only those who self-identify as environmentally conscious.

There are also components I would add to future iterations of the survey. First and foremost, I did not collect any information that could have provided a spatial component to my analysis. While I know all of my respondents currently reside in Oklahoma, I do not have any data to indicate which parts of the state they live in. Collecting this information could have allowed me to analyze what different regions within the state knew about wind energy development and what trade-offs individuals in those regions would be willing to make; this may have revealed trends in responses based on location. If I were to extend this survey to the general public, I would include a question asking respondents to identify what county they currently reside in. In addition, this survey was restricted to those who currently reside in Oklahoma. The analysis would have been different if this survey had been more widely distributed, to potentially include Kansas and Texas, which also both have wind energy development within their borders. Being able to compare between states may have also provided interesting spatial trends within responses.

The “green on green” framework also offers opportunities for application to other technology within the renewable energy sector. For example, solar technology is another innovation for which both sides of the environmental debate have sound arguments for why it is beneficial or detrimental. As there is currently no literature applying Warren et al.'s (2005) "green on green" framework to the solar industry, it represents an opportunity to expand this framework beyond wind energy. This "green on green" conflict framework also provides a lens through which practitioners can understand what opposition is based on when it comes to conflicts with solar (especially utility scale), which is why it would be valuable to distribute a survey similar to this one, focusing instead on solar versus wind.

While the "green on green" conflict framework is a valuable lens through which to evaluate public perception, this survey could also have been performed to evaluate the economic components of wind energy development. Instead of the survey focusing on the environmental pillar of sustainability, it would focus on the economic pillar and also be more inclusive of the social pillar. Replacing the knowledge of environmental impacts section with economic impacts (such as job opportunity, tax dollars, etc.) could assist in measuring the awareness of individuals in regards to the economic benefits of wind energy development. The trade-off section could be reframed to compare various trade-offs with one another, versus focusing specifically on biodiversity conservation. It would still be of value to include attitudes towards biodiversity conservation and renewable energy as independent variables in statistical analyses, to not only include the "green on green" conflict in more general public perception work but to also provide additional insight into the balance of these two concepts when compared to social and economic benefits.

In addition to an extended statistical analysis, the survey I conducted included additional questions that were not included in the final publication of this work. These questions included multiple open response questions related to knowledge about the impacts of renewable energy development and biodiversity conservation on one another as well as about how individuals thought these impacts could be mitigated. Analyzing these questions involved a methodology that is outside of the scope of my academic career up until this point, which is why they were not included in this project. I do, however, intend on studying these methods and utilizing the responses provided by my respondents to produce two additional papers. I will briefly describe them below, as they represent two viable options for future research beyond extending my survey to the general public.

3.3 Future Work

Based on the outcome of the survey, it became apparent towards the end of this work that additional analysis could be performed on the results of this survey that were outside of the scope of the original thesis. In future work, I would like to use the survey results to look at two additional research questions. The first set of research questions would be related to a quantitative content analysis of open-ended questions related to knowledge about the impacts of wind energy development and biodiversity conservation, using this method to determine if there are any trends in responses. The second research question would be “how do environmentally conscious individuals respond to the concept of framing renewable energy as a solution to environmental problem”, accomplished via a qualitative content analysis to identify themes within the open-ended responses provided by participants. I will present in this section an outline of what these papers and their associated methodology would look like.

3.3.1. Content analysis of open-ended responses

The first avenue for future research could be a quantitative content analysis on questions that asked respondents: 1) how they felt about renewable energy impacts on the environment; 2) how much they knew about current research; 3) whether or not they felt conservation limited renewable energy expansion; 4) how they thought it would be possible to mitigate wildlife-related impacts due to turbines; and 5) why they would or would not support future development. While a survey with delineated responses provides an avenue through which to statistically analyze responses to determine potential relationships, open-ended questions provide an opportunity to produce a narrative to accompany a statistical analysis. These five questions provide additional context, and it would be valuable to perform a content analysis to look for trends and commonalities among responses. While the research presented in question two asks individuals questions related to what they know about the impacts of wind energy development on biodiversity conservation, the additional open-ended questions that would be utilized here provide insight into where individuals receive their information and also provide a narrative associated with their current stance on the two topics of interest. While the statistical analysis presented in chapter two offers information on current knowledge about and attitudes toward renewable energy development, the narrative provided by open-ended questions and the resulting content analysis can provide specific examples that policymakers and developers could utilize.

There are three broad possible applications of a content analysis: describing attributes of the text, making inferences about the sender and its causes or antecedents, or making inferences about the effect of the message (Frankfort-Nachmias et al., 2015). This research would utilize the first application of content analysis, to describe the attributes of the open-ended response answers provided by participants. The recording unit for this analysis would be words or terms, to identify how frequently particular ideas are identified by respondents. This research would employ categories related to “what is said”: 1) subject matter or what the text is about; 2) methods or what is used to achieve a goal, which has been presented in some of the questions; and 3) conflict, or what are the sources or level of issues (Frankfort-Nachmias et al., 2015). Data would be coded utilizing either an appearance system, in which I would search for the appearance of certain components, or a frequency system, where the responses would be coded according to the number of times an attribute occurs, depending on the question and context (Frankfort-Nachmias et al., 2015).

The content analysis of responses to the five specific questions identified will provide insight into how individuals specifically perceive the nuances of wind energy development and biodiversity conservation. A content analysis allows for the identification of patterns in responses that may not be made clear in delineated, pre-determined survey question responses and the associated bivariate or multivariate analysis. This content analysis could then be accompanied by a summarization of the results of this research, to provide a more inclusive picture of experience. Combining the quantitative analysis performed in chapter two with this proposed research into one paper would have truncated analysis of both of these components, which is why this qualitative analysis warrants its own research project.

3.3.2. Qualitative analysis of responses to how renewable energy development should be framed

In addition to the open-ended questions listed above, another area of work would be to delve more deeply into the question I asked respondents: if they believed that “posing wind energy as a solution to environmental problems benefits future wind energy development and support?” This question is rooted in an idea presented by Olson-Hazboun et al. (2016), when they noted in their discussion that “residents… are simply less likely to employ an environmental rationale when forming opinions about issues like energy development…” They conclude that “those engaged in the advancement of renewable energy in politically conservative contexts may find it useful to cease to frame development of wind or solar energy as an environmentally motivated issue.” In completing my literature review, I came across this point and it is because of Olson-Hazboun et al.’s (2016) conclusion that this specific question was included in the survey. Completing a textual analysis on the responses to this question could provide a useful paper within the discourse of how we communicate sustainability and sustainability goals. In reading through some of the responses, some participants, despite being environmentally conscious individuals, recognized that rooting renewable energy development in environmental motivations is often not as effective as the economic or social benefits argument. I, therefore, think an in-depth analysis of the responses I received can lead to a manuscript which provides interesting, qualitative insight on how individuals view our current framing of renewable energy development.

The best way to approach this analysis, because of its qualitative nature, would be to utilize a thematic analysis, the methodology for completing a content analysis with qualitative versus quantitative data. A qualitative thematic analysis tends to mix methods, as described by Silverman (2014) in his section on qualitative thematic analysis: 1) it looks at the lives of participants by what they say; 2) it aims to ground analysis from the perspective of the participant versus the researcher; and 3) data is typically presented by describing social phenomena, via quotations. It is three components that I feel are captured by the responses to the open-ended survey question I am interested in and why I would like to apply a thematic analysis.

It is important to note that Silverman (2014) describes thematic analysis within the context of analyzing focus group transcripts, and a shortcoming identified is that a thematic analysis often loses the context of the conversation from which it is pulled. Because my responses are not part of a larger piece of conversation, the concern of losing context is not an issue, so there is validity in using a qualitative thematic analysis for the purpose of this research. A thematic analysis operates similarly to the way one would perform a quantitative content analysis, in that I need to identify a unit of analysis (individual responses in this case), develop my coding system and code the responses accordingly. The biggest difference between my quantitative and qualitative content analyses is that my qualitative analysis will be based in quotations, presenting these quotations within the overarching themes identified via the coding process (Silverman, 2014).

This qualitative content analysis will provide a unique perspective into how the "green on green" conflict is currently proliferated by discourse and how we can potentially present environmental innovation differently to avoid this conflict. Understanding how communities perceive the current methods of discourse can provide guidance to developers. It can help to provide insight that may change how a project is presented to a community, focusing on other beneficial components versus orienting the argument around mitigation of climate change and adaptation to impacts. Olson-Hazboun et al. (2016) found that their respondents were not interested in the environmental benefits of wind energy development, and in posing this question in their own research, illuminated an incredibly interesting avenue for future, more qualitative work to understand different narratives.

3.4 Concluding remarks

Overall, this research represents another piece of scholarship within a currently small body of research on perceptions of wind energy development in the state of Oklahoma. My findings provide insights into what environmentally conscious individuals know about the impacts of wind energy development and also provide a preliminary analysis of what types of trade-offs individuals are willing to make regarding wind energy development. The two future research projects I intend on doing with the data I have collected, in addition to adding to the literature, will provide an important qualitative component to the narrative of public perception of wind energy in the state of Oklahoma. As development of renewable energy projects continues, it is important that the context of development is understood, which is why these public perception projects are so important.

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Appendix A

The content of this appendix is the original survey used for the research in chapter 2.

Q1. How do you feel fossil fuels impact the environment?
Negatively (1) - Positively (7)

Q2. How do you feel renewable energy impacts the environment?
Negatively (1) - Positively (7)

Q3. Please explain your feelings about renewable energy impacts on the environment in 100 words or less.

Q4. How much do you care about...

	1 (Don't care at all)	2	3	4 (Indifferent)	5	6	7 (Care very much)
Biodiversity conservation	○	○	○	○	○	○	○
Renewable energy development	○	○	○	○	○	○	○

Q5. How do you feel that renewable energy impacts wildlife and wildlife conservation?
Negatively (1) - Positively (7)

Q6. What do you know about the current research on biodiversity conservation and renewable energy? Please explain in 100 words or less. If you are not familiar with current research, please just put "not familiar" in the text box below.

Q7. Next, here are some statements about renewable energy and wildlife. Please indicate whether you think each statement is true or false.

	False	True	I don't know
Wind turbines cause bird mortality due to collision.	○	○	○
Wind turbines cause bat mortality due to collision.	○	○	○
Bats suffer internal injury due to wind turbines.	○	○	○
Wind turbines make habitat unsuitable for wildlife.	○	○	○
Infrastructure related to wind turbines can cause habitat fragmentation.	○	○	○
Wind turbines can cause erosion.	○	○	○
Development of wind turbines can lead to proliferation of invasive species.	○	○	○
Wind turbines can cause changes in local climate such as temperature range and precipitation levels.	○	○	○

Q8. What do you think is the leading cause of bird mortality?
Wind turbine collision
Cats
Collision with buildings
Collision with power lines
Collision with cars
I don't know

Q9. What do you think is the leading cause of bat mortality?
Wind turbines
Disease (white-nose syndrome)
Killed by humans - viewed as pests
Floods, droughts, and other natural disasters
Loss of nest sites
I don't know

Q10. Do you believe that biodiversity conservation limits renewable energy expansion? Why or why not?

Q11. Do you believe posing wind energy as a solution to environmental problems (i.e. reduction of emissions due to fossil fuels) benefits future wind energy development and support? Why or why not?

Q12. If wind energy had **fewer impacts on biodiversity conservation** but **negatively impacted the integrity of the natural landscape** (visually unappealing), I would be...
Very opposed to development (1) - Very supportive of development (7)

Q13. If wind energy **negatively impacted biodiversity conservation** but **had little to no impact on human health** such as sleep loss, headaches, etc., I would be...
Very opposed to development (1) - Very supportive of development (7)

Q14. If wind energy led to **economic growth and opportunity** in my community but **negatively impacted biodiversity conservation**, I would be...
Very opposed to development (1) - Very supportive of development (7)

Q15. If wind energy **included public participation and opinion** (from community members, politicians, researchers, and developers via public forums, meetings, etc.) but till had **negative impacts on biodiversity**, I would be...
Very opposed to development (1) - Very supportive of development (7)

Q16. If wind energy resulted in **higher energy prices** but **did not impact biodiversity conservation**, I would be...
Very opposed to development (1) - Very supportive of development (7)

Q17. If wind energy was **accessible for you to utilize instead of being transported to other regions** but **negatively impacted biodiversity conservation**, I would be...
Very opposed to development (1) - Very supportive of development (7)

Q18. How do you think it is possible to mitigate wildlife-related impacts due to wind turbines?

Q19. How would you feel about wind energy development near your home or in your community?
Would not support (1) - Would support (7)

Q20. Please explain why you would or would not support development.

AGE. What is your age?

GENDER. What is your gender?
- Male
- Female
- Non-binary

RACE. What is your race/ethnicity?
- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- Hispanic
- Middle Eastern
- Not listed

If they selected race as not listed…
RACE2. Please explain.

OKRES. Are you currently an Oklahoma resident?
Yes
No

If they selected yes for being an Oklahoma resident…
OKRES2. How long have you lived in Oklahoma (years)?

If they selected no for being an Oklahoma resident…
RES3. Where are you from (state or country if you are from abroad)?

EDU1. Are you currently attending an institution of higher education?
Yes
No

If they selected yes for being in an institution of higher education…
EDU2. What degree are you currently working on?
Associate's
Bachelor's
Master's
Doctorate
Post-doctorate

If they selected no for being in an institution of higher education…
EDU3. What is your highest level of education?
High school or equivalent
Trade school
2-year degree
4-year degree
Master's
Doctorate

JOB. What is your current job title?

INCOME. What is your current annual income (US$)?

Less than $10,000
$10,000 - $19,999
$20,000 - $29,999
$30,000 - $39,999
$40,000 - $49,999
$50,000 - $59,999
$60,000 - $69,999
$70,000 - $79,999
$80,000 - $89,999
$90,000 - $99,999
$100,000 - $149,999
More than $150,000

POL1. What is your political affiliation?

Democrat
Republican
Independent
Other
None

If they selected political affiliation as other…
POL2. Please explain your political affiliation.

POL3. Do you consider yourself more conservative or liberal?

Conservative (1) - Liberal (7)

PROX1. Do you or have you ever lived near wind turbines (whether it was only one or two or a wind farm)?

Yes
No
Not sure

PROX2. Do you or have you ever lived near a protected natural area (state park, national park, wildlife refuge, etc.)?

Yes
No
Not sure