GONE WITH THE WIND: A LOOK AT THE IMPACTS OF WIND DEVELOPMENT ON WILDLIFE

An Undergraduate Research Scholars Thesis

by

LAUREN NAYLOR

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TABLE OF CONTENTS

ABSTRACT

Gone with the Wind: A Look at the Impacts of Wind Development on Wildlife

Lauren Naylor
Department of Wildlife and Fisheries Sciences
Texas A&M University

Research Advisor: Dr. Michael Masser
Department of Wildlife and Fisheries Sciences

Climate change is an ever-growing problem that has gained increased public and political attention in recent years. Energy production is one of the major sectors that influence our overall emission rates that contribute to climate change. One of the potential solutions lies in an increased development of wind energy. Wind energy offers a cleaner production alternative that not only helps to reduce emissions, but that will also increase the diversity of our nation's energy portfolio. Wind energy does not, however, come without its own costs. The potential negative impacts of widespread wind energy development need to be carefully considered.

The question this project intends to answer is, with regard to injuries sustained by birds of prey as a result of direct collisions with wind farms, how many of the affected birds can be rehabilitated, and what level of recovery they most often reach. The project will consist of three major parts: a literature review, survey data, and post-survey interviews. The literature review will be used to develop background knowledge of the potential negative impacts that wind development may have on wildlife populations, specifically those of raptors. Raptors were chosen because of their slow reproductive cycles and long lifespans, relative to other

bird species. The second phase will consist of a survey that will be sent out to raptor rehabilitation centers in the six states that contain the largest percentage of wind development (Texas, Oregon, Washington, California, Iowa and Minnesota). This survey will provide a new source of data by addressing local rehabbers, and thereby exploring a local aspect of the human dimension that is often overlooked. The last phase of this project will involve evaluating the opinion of experts in the field. The objective of these separate steps is to integrate biological and social sciences through the analysis of both peer-reviewed literature and local knowledge (i.e. information gained from surveys and interviews), in order to create a more comprehensive picture of a problem and its potential solutions.

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CHAPTER I

INTRODUCTION

The push for renewables

In recent years, climate change has become a hot topic in both the scientific and political realms. Debates regarding the level of anthropogenic contributions to climate change have begun to sway the public to take action. Energy production is one of the major sectors that influence our overall emission rates contributing to climate change, where as much as 40% of U.S. emissions are produced by the electric sector alone. With a projected growth of 39% in U.S. electricity demands by 2030, this problem of high emission rates is not likely to disappear unless drastic changes are made (DOE, 2008). One of the ways of decreasing emissions potentially lies in increased reliance of renewable resources. For the purposes of this paper, we focus specifically on wind energy development.

Why wind?

According to the Department of Energy, the U.S wind industry is experiencing growth due to "sustained production tax credits (PTC), rising concerns about climate change, and renewable energy portfolio standards (RPS) or goals in roughly 50% of the states" (DOE, 2008). The benefits of increased wind energy are numerous: reductions in greenhouse gas emissions, job creation, and the saving of 4 trillion gallons of water (Glen, Barho, Evans, 2013). It is believed that these benefits can further serve society by addressing challenges such as air quality, public health and water scarcity in addition to the poster problem of climate change (DOE, 2015).

Wind energy offers a cleaner production alternative to fossil fuels that helps to reduce emissions while simultaneously providing a native energy resource that increases the diversity of our nation's energy portfolio.

Potential impacts to wildlife

As renewable energy sources such as wind power grow in popularity, the resulting impacts on the environment are becoming more apparent. Studies indicate that the increasing use of wind power can have negative effects on the surrounding wildlife; including but not limited to many raptor species. These impacts can be both direct (i.e., through collision fatalities), as well as indirect (i.e., habitat loss). Negative impacts associated with operational wind farms include direct collision mortalities from towers or transmission lines, barotrauma (internal hemorrhaging) for bats, and unpleasant aesthetics for the surrounding communities. Consequences resulting from construction and related infrastructure can include loss of habitat, habitat avoidance, and habitat fragmentation (Glen, Barho, Evans, 2013). The potential effects on protected and migratory species are of particular concern, especially for wind farms located along important migratory flyways.

Policy and Mitigation Implications

There are already several laws in existence that will likely play a role in determining how and where wind farms can operate. Laws and regulations pertaining to migratory and federally listed birds in the U.S. include the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), and the Bald and Golden Eagle Protection Act (Eagle Protection Act). Each of these pieces of legislature has the potential to affect the operation of domestic wind farms (Glen, Barho, Evans, 2013). One major area that could be influenced is mitigation, and the

options that are available for both pre- and post-development. The creation of siting regulations could provide a viable form of pre-development mitigation. Disturbance-based siting, for example, encourages development in areas that have already been disturbed, and thereby help preserve areas of quality habitat (Kiesecker, Evans, Fargione et. al, 2011). Post-development mitigation options also exist. These mostly include structural changes to turbines, wind farm layouts, and operational adjustments. This project stands to offer insight into a potential post-development mitigation option by examining local knowledge and previously unused quantitative data.

This research explores the questions surrounding recovery potential for impacted birds, such as how many of the affected birds can be rehabilitated, and what level of recovery they most often reach. From this investigation we stand to gain a better understanding of the threats wind farms pose to birds of prey, better data on injury frequency and severity, and draw conclusions about the type of environmental compensation that could be provided in exchange for increased wind development.

CHAPTER II

METHODS

Methodology

The goal of my research project was to determine, with regard to injuries sustained by birds of prey as a result of direct collisions with wind farms, how many of the affected birds can be rehabilitated, and what level of recovery they most often reach. My project consisted of three major parts: a literature review, survey data, and post-survey interviews. As the undergraduate student I was responsible for the implementation of these steps, with my advisor providing guidance and then reviewing and approving the final products.

Phase one – literature review

The literature review was used to develop background knowledge of the potential negative impacts that wind development may have on wildlife populations, specifically those of raptors. Raptors were chosen because of their slow reproductive cycles and long lifespans, relative to other bird species. To conduct the literature search two key search phrases were used, "Raptor impacts from wind development" and "Wind development and wildlife policy." The time parameter was set to the period between 2008-2015. This period was chosen in order to span the length of time since the Department of Energy published its goal of having 20% of the U.S. electricity demand produced by renewable energies by 2030. The search engine Google Scholar and resources provided by TAMU Libraries (i.e. access to databases such as EBSCO) were used, with searches ending at the fourth and first pages respectively. The resulting bulk of literature was then sorted according to the following criteria:

A) Content specifically discussed birds of prey

B) The article focused on wind energy in the U.S.

C) Online access to the literature was available

Phase two – survey distribution

The second phase consisted of a survey that was sent out to raptor rehabilitation centers in the six states that contain the largest percentage of wind development in the United States (Texas, Oregon, Washington, California, Iowa and Minnesota (Fischlein et. al, 2014)). The questions included in this survey covered topics such as the type of injuries sustained by birds, how many of these injuries were the result of wind farms, and the percentage of these birds that were eligible to be re- released. This survey aims to provide a new source of data by addressing local rehabbers, and thereby exploring a local aspect of the human dimension that is often overlooked. These surveys were created using Qualtrics and distributed through email. The contact information for the rehabilitation centers surveyed was found on rehabilitation lists that were published on the individual state department websites. A consent form was issued at the start of the survey, and all information was kept in the Qualtrics database. The contacted rehabilitation centers were chosen based off of the following criteria:

1) Center was listed as a certified rehabilitation center
2) Contact information was accessible to the public
3) Center was located in one of the six survey states
4) Center treated birds of prey

All rehabilitation centers that met the criteria were contacted and asked to participate after

receiving a brief explanation of the project.

Phase three - interview

The last phase of this project involved evaluating the opinion of experts in the field, to not only gain a better understanding of their professional opinion, but also to be able to compare and contrast the views of researchers and of local rehabbers. The objective of these separate steps is to integrate biological and social sciences through the analysis of both peer-reviewed literature and local knowledge (i.e. information gained from surveys and interviews), in order to create a more comprehensive picture of a problem and its potential solutions.

CHAPTER III

RESULTS

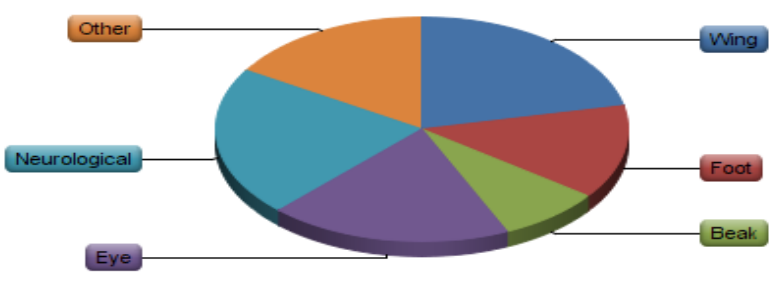
Survey Data

Surveys were sent to either rehabilitation centers or individuals with a state certification for wildlife rehabilitation. 76 surveys were distributed, with the highest number being sent to Texas. 24% of the distributed surveys were returned completed. The surveys conveyed important information regarding injury type, species treated, and opinions regarding mitigation options. Data was also collected in interviews with individuals involved in bird rehabilitation.

The surveys revealed that the Red Tail Hawk (*Buteo jamaicensis*), Great Horned Owl (*Bubo virginianus*), American Kestrel (*Falco sparverius*) and Red-shouldered Hawk (*Buteo lineatus*) were the most commonly treated birds across multiple states. 94% of those surveyed reported that wing or neurological injuries were the most common. These were the only two injuries to be reported by every rehabilitation center surveyed. The figure below displays the breakdown of all injuries as cumulatively reported by those surveyed, without separating out for state or overlap.

Figure 1: Injury Types Treated

This figure demonstrates the breakdown of injuries as cumulatively reported by all those surveyed.



Wing injuries typically consisted of compound fractures or open lacerations. Reported neurological injuries included ataxia, which is the loss of full control of body movements, and nonambulatory injuries, meaning the bird is unable to walk about. The least common type of injuries reported were those to the beak. The category for "other" injuries included reports of malnutrition, electrocution, poisoning, and gunshot wounds among others.

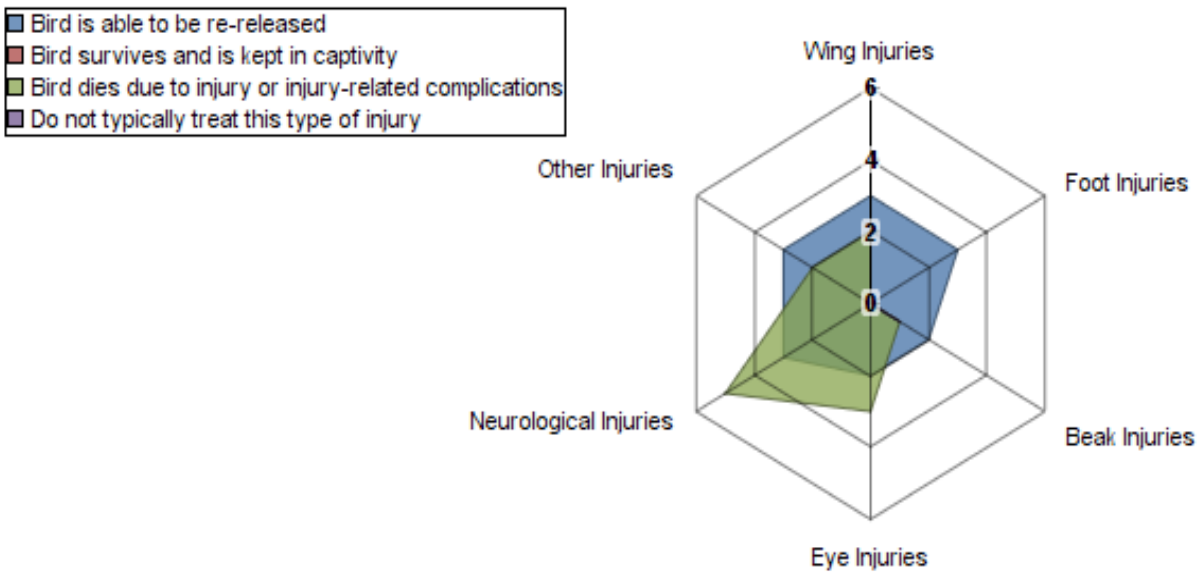


Figure 2: Typical Outcomes of Respective Injury Types

According to an interview with Luke Hart, the Executive Director of the RARE (Raptor Advocacy, Rehabilitation, and Education) group in Iowa, non-life threatening wing injuries at his center have a full recovery rate (meaning they are able to be re-released) of 30-40%. Figure 2 demonstrates the outcomes of different injury types, and emphasizes the low success rates associated with neurological injuries.

73% of the rehabbers surveyed believed that they were within 100 miles of a wind farm. However, only 40% of these believed that they had treated birds that had sustained injuries from wind farm collisions. Most rehabbers surveyed expressed a low expectation for the likelihood that they had treated birds with injuries sustained by wind farm collisions, with the highest estimate being 20% of birds treated could potentially have suffered from a related injury.

With regard to opinion on mitigation, 87% called for pre-development mitigation options as opposed to post-development mitigation or restitution. In fact, 100% of those surveyed preferred that wind farms minimize their impact on wildlife instead of simply providing restitution. Examples provided by the survey for each category included changing blade design or wind farm layout, or the payment of fines, respectively.

Interview Data

Interviews were conducted with experts in the field, from both rehabilitation and advocacy groups. Questions were tailored to the expertise of each individual interviewed, but in general asked for opinions regarding the extent of the impact that wind energy is having and what type of solutions should be pursued. Interviews were conducted with individuals from bird advocacy groups and rehabilitation centers.

To represent the local rehabilitation centers we interviewed Mr. Luke Hart, Executive Director of the RARE (Raptor Advocacy, Rehabilitation, and Education) group in Iowa. This organization takes in close to 200 birds a year from the eastern Iowa area and Illinois. In

addition to rehabilitation, they do educational programming and conduct simple research studies. Mr. Hart has never in his experience worked directly with birds that have been injured due to collisions with wind farms. He claims that it is hard to tell what exactly happened to the birds when they are brought in. He has never personally been contacted by a wind company to retrieve or treat an injured bird, but says he would gladly accept that call. When asked about his opinions on the likelihood of recovery, Mr. Hart was not overly optimistic. With operating speeds of 150-170 mph (Hutchins pers. comm.), the turbines have what Mr. Hart calls a "slice-and-dice" effect. He believes that a collision with these turbines would result in either immediate death, or a traumatic injury that is unable to be treated. According to Mr. Hart, the state of Iowa has laws in place that dictate how particular injuries are to be treated. The loss of a wing or leg, for example, would result in the animal being euthanized. Therefore even if the animal survives the collision, the type of injuries that are likely to be sustained may still result in death by euthanasia (Hart pers. comm.). This assumed high mortality rate contributed to his opinion that the initial design of wind facilities is key when it comes to the minimization of impacts on birds of prey. He cites the problem of shared resources; the wind that birds use to propel themselves in flight is the same wind that wind energy companies are trying to harness, therefore they end up in the same location. Mr. Hart believes that reducing the "slice-and-dice" effect of wind turbines by changing their design will be the most effective way to minimize both the rate and severity of injuries.

He would also like to see energy companies conducting more extensive impact studies, so that a more informed baseline can be established along with a more thorough understanding of the potential impacts. In Mr. Hart's eyes the situation is clear, "Can we do more to protect our wildlife with these new energy projects? The answer is yes."

We also interviewed Dr. Michael Hutchins the Director of the ABC (American Bird Conservancy) Bird-Smart Wind Energy Campaign. This group aims to improve decision-making, understand the impacts of wind energy, and push for better regulations to avoid bird and bat deaths caused by commercial wind energy. Dr. Hutchins claims that many conservation organizations have embraced wind energy without asking enough questions, and this campaign aims to ask those tough questions. When asked about his opinions on the types of injuries sustained by birds from collisions and their chances at recovery, Dr. Hutchins expressed concern that the injuries would be too extensive. He believes most birds die on impact, and that those that survive would both be difficult to find and difficult to treat. Overall, he views the potential to use rehabilitation as a form of mitigation to be extremely limited. As an alternative solution, he would prefer that wind facilities be moved out of areas with high bird abundance, such as along migratory flyways.

Dr. Hutchins revealed yet another obstacle to the use of rehabilitation as a form of post-development mitigation; the lack of publically available information. It is difficult to get a full picture of the number of birds that are injured or killed each year due to collisions with wind turbines because the mortality data is not readily accessible. According to Dr. Hutchins, the lack of transparency between wind facilities and the public presents a major problem. He cites the lawsuit that Pacificorp brought against the U.S. Fish and Wildlife Service (USFWS) in 2014 to block the release of information regarding bird deaths at their facilities as evidence of this lack of transparency. He believes that the collection of the mortality also presents a possible bias, as the data is collected by paid consultants to the industry, as opposed to independent researchers. This data isn't even required to be collected, as the protocols are

entirely voluntary (Hutchins pers. comm.). In addition, Dr. Hutchins brought up a more recent attempt to move all available mortality data and place it into a database held by the American Wind Wildlife Institute (AWWI). This would make the information anonymous and impossible to FOIA, which he believes is an attempt to further hide this data from the public (Hutchins pers. comm.; Haugen 2013). In his opinion, birds of prey are a public trust resource that is held by the American public, and it is the job of USFWS, among other agencies to protect these resources.

When asked about their opinions on how serious of a threat they believed wind farms posed to birds of prey, both Mr. Hart and Dr. Hutchins believed it to be a non-trivial threat. The losses are cumulative, and when all the anthropogenic influences are added up the losses are significant. The turbines aren't the only danger, as the associated infrastructure (power lines, communication towers, etc.) also kill birds through collisions and electrocution (Hutchins pers. comm.). Renewable energy has considerable positive impacts, but more can and needs to be done to protect our wildlife with these new energy projects (Hart pers. comm.). An additional contribution to the severity of this threat is the lack of enforcement of certain wildlife policies. The prosecution for killing large numbers of birds, specifically protected species, has been miniscule. The federal government has not been consistent in enforcing important acts, such as the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act, among others. To date there have only been two prosecutions, brought against Pacificorp and Duke Energy, although it is likely that several other companies that have violated these policies (Hutchins pers. comm.). Both men also called for additional impact assessments, as well as increased research and development surrounding alternative blade designs and technologies.

CHAPTER IV

DISCUSSION

Limitations

There were several possible limitations associated with this project. The location of the rehabilitation centers in relation to wind farms varied from state to state. For example, several individuals that were contacted commented that a majority of wind farms in Washington were located in the eastern part of the state, while their rehabilitation center was not. This could have an effect on the amount of relevant data produced from each state. In addition, not all rehabilitation centers that were contacted responded or agreed to participate. The centers that did respond were not always able to say with certainty that the injuries sustained by birds were the result of collisions with wind farm infrastructure.

Results Analysis

The data collected by the distribution of surveys provided a more quantitative view of the types of injuries sustained and how many were able to be re-released. The data collected through interviews helped to flush out the answers provided through the surveys, and offered added insight into the hurdles facing rehabilitation as a mitigation strategy.

An interview with Mr. Hart helped to explain the low percentage of rehabilitation centers within 100 miles of a wind farm that believed they had treated birds injured by these facilities. Of those surveyed, 73% believed that they were within 100 miles of a wind farm. Only 40% of these, however, believed that they had treated birds that had sustained injuries from wind

farm collisions. According to Mr. Hart, this could be because birds that are injured in collisions either die on impact due to the "slice-and-dice" nature of the turbines, or have to be euthanized. In some states, such as Iowa, the law dictates how certain injuries can be treated. A bird that is missing a wing or leg, for example, must be euthanized. As most birds that survive collisions with wind turbines are likely to have traumatic injuries, such as missing wings, even the survivors are likely to be unable to have a successful outcome. Mr. Hart also mentions an uncertainty that often surrounds causations of injuries. He claims that with most birds it can only be guessed what happened to them, and that in his experience a wind company has never contacted him to retrieve an injured bird. The combination of uncertainty of causation with injuries and the low chance for survival after impact with a turbine help to explain the absence of wind-farm related injuries in adjacent rehabilitation centers.

Alongside the issues associated with the lack of recovery potential for birds injured by wind farms, Dr. Hutchins' interview helped to shed light on the political and social components of the conflict between wind energy development and wildlife. With policies such as the Bald and Golden Eagle Protection Act imposing fines on companies that cause deaths of protected species, companies are not likely to be willing to report injured birds if they think it might get them in trouble. At the same time, however, these policies have not been heavily enforced. With only two prosecutions against wind companies for violations of these policies, the track record for protecting species by threatening consequences is not particularly strong. Policies that are supposed to be helping preserve our wildlife are now both preventing wind companies from being cooperative and failing to discourage companies from harming birds in the first place. This type of atmosphere is incredibly ineffective, and will need to be resolved before any real progress can take place. Either our wildlife agencies need to be more active and help

our policies have teeth, or steps should be taken to incentivize wind farms to take preventative measures.

This study's blend of scientific literature, professional expertise and local knowledge offers a unique look at a complex issue. By assessing the knowledge of local rehabbers, who are on the front lines and deal directly with injured birds, we were able to gain a fuller understanding of the recovery rates for the injuries that birds would result from collisions. This helped us to predict the likelihood of being able to "repair damage done" after birds are hit. By identifying the probability for low survival rates, we were then able to conclude that preventative measures are better taken before injuries are incurred. This enabled us to have an informed platform when we began talking with experts in the field, who were better able to explain to us the reasoning behind some of the obstacles we experienced. They then offered their own professional opinions about future solutions, which we were later able to use our reasons for failure assess their chances for success. We determined that overall, pre-development mitigation strategies (e.g. siting, blade design, etc.) are preferred and would not experience all the same problems that our proposed solution did.

CHAPTER V

CONCLUSION

Even with the limitations of our study, we have uncovered some interesting pieces that can prompt future research. We have found that the injuries that are likely to be sustained from collisions with wind farms are unlikely to have a high success rate with rehabilitation. Either the bird will die on impact, or suffer an irreparable traumatic injury that will result in euthanasia. This low success rate suggests that the use of rehabilitation as a form of post-development mitigation would be ineffective. In addition, we determined that the current state of communication and cooperation between wind energy facilities and wildlife agencies is not favorable for the creation of this type of program. In order to achieve a successful approach through rehabilitation, wind companies would need to be more willing to report injured birds and allow for their collection. The lack of incentive for wind companies to report their injured birds is a serious obstacle that would need to be overcome before implementation of a cooperative program could occur. We also found that amongst local rehabbers, pre-development mitigation strategies are preferred over post-development strategies, and that in all cases minimization of impacts to wildlife is favored over restitution. This information should be used to direct mitigation efforts and focus attention on the areas that are believed to be the most effective.

Implications for Future Research

This project served as a pilot study intended to highlight gaps in the current research on the impacts of wind development, and points to a need for further research to be done. Our findings suggested that, as it stands, rehabilitation is not a viable mitigation option due to the

severity of injuries sustained and the lack of cooperation in the industry. In order to remedy some of these obstacles, more studies will need to be done to look into potential solutions. Design options that reduce the severity of injuries, bladeless technologies (e.g. Sheerwind technologies), and the creation of proper siting regulations are all possible resolutions that should be further studied and developed. This particular study demonstrates the usefulness of using local knowledge to understand large-scale problems. Follow-up research could include using this form of local knowledge to inform the preferred option of pre-development mitigation strategies. This project could be improved upon by conducting more extensive surveys that focus on collecting quantitative data, and interviewing additional experts from NGOs, governmental agencies and rehabilitation centers in all states. If increased transparency could be reached, the mortality data collected by individual wind companies could also prove useful to strengthening our understanding of both the problem and potential solutions. Overall, our findings suggest that there is still a lot of uncertainty surrounding the extent of impact that wind energy is having on birds of prey, as well as the effectiveness of mitigation strategies. Our results support a need for additional studies.

REFERENCES

Benítez-López, A., Alkemade, R., & Verweij, P. A. (2010). The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis. *Biological Conservation*, 143(6), 1307-1316. doi:10.1016/j.biocon.2010.02.009

Cole, S. G. (2011). Wind Power Compensation is not for the Birds: An Opinion from an Environmental Economist. *Restoration Ecology*, 19(2), 147-153. doi:10.1111/j.1526-100x.2010.00771.x

DOE. (2015) *Wind Vision: A New Era for Wind Power in the United States*. U.S. Dept. of Energy, Energy Efficiency and Renewable Energy. Web.

DOE. (2008) *20% Wind Energy by 2030 Increasing Wind Energy's Contribution to U.S. Electricity Supply*. U.S. Dept. of Energy, Energy Efficiency and Renewable Energy. Web.

Fargione, J., Kiesecker, J., Slaats, M. J., & Olimb, S. (2012). Wind and Wildlife in the Northern Great Plains: Identifying Low-Impact Areas for Wind Development. *PLoS ONE,* 7(7). doi:10.1371/journal.pone.0041468

Fischlein, M., Feldpausch-Parker, A. M., Peterson, T. R., Stephens, J. C., & Wilson, E. J. (2012). Which Way Does the Wind Blow? Analysing the State Context for Renewable Energy Deployment in the United States. *Environmental Policy and Governance*. doi:10.1002/eet.1636

Glen, A. M., Barho, R. D., & Evans, L. M. (2013). How federal wildlife laws impact development of wind energy. *Trends : ABA Section of Environment, Energy, and Resources Newsletter, 44*(4), 14-17. Retrieved September 3, 2015.

Haugen, D. (2013, June 20). Wind-wildlife group begins building bird-death database. *Midwest Energy News.* Retrieved from http://midwestenergynews.com/2013/06/20/wind-wildlife-group-begins-building-bird-death-database/

Kiesecker JM, Evans JS, Fargione J, Doherty K, Foresman KR, et al. (2011) Win-Win for wind and wildlife: a vision to facilitate sustainable development. PLoS ONE 6(4): e17566. doi: 10.1371/journal.pone.0017566

Northrup, J. M., & Wittemyer, G. (2013). Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation. *Ecology Letters* Ecol Lett, 16(1), 112-125. doi:10.1111/ele.12009

Miller, T. A., Brooks, R. P., Lanzone, M., Brandes, D., Cooper, J., O'malley, K., Katzner, T. (2014). Assessing Risk to Birds from Industrial Wind Energy Development via Paired Resource Selection Models. *Conservation Biology*, 28(3), 745-755. doi:10.1111/cobi.12227

Mockrin, Miranda H., and Rebecca A. Gravenmier. *Synthesis of Wind Energy Development and Potential Impacts on Wildlife in the Pacific Northwest, Oregon and Washington*. Vol. 863. Portland: USDA, Forest Service, Pacific Northwest Research Station, 2012. Web.

RENEWABLE ENERGY IN THE CLEAN POWER PLAN. (2015, October 16). Retrieved from https://www.epa.gov/sites/production/files/2015-11/documents/fs-cpp-renewable-energy.pdf

Smallwood, K. S., & Karas, B. (2009). Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California. *Journal of Wildlife Management*, 73(7), 1062-1071. doi:10.2193/2008-464

APPENDIX A

List A: Interview Questions- Mr. Luke Hart

1.) Please describe your job and the type of work that you do with birds of prey
2.) Have you ever directly worked with birds injured by wind turbines or related infrastructure? If so, can you please describe your experiences?
3.) In your opinion, are the types of injuries typically sustained by birds due to collisions with wind farm structures able to be successfully treated (meaning that they are re-released)?
4.) What is your professional opinion regarding wind farms and their impact on birds of prey?
5.) What type of solution do you think would be most effective in minimizing the impact of wind farms on birds of prey? (Ex: siting regulations, changes in turbine design and layout; things that can be done before vs. after development)
6.) What motivates you to do the work that you do?

List B: Interview Questions- Dr. Michael Hutchins

1.) Please describe your job and the type of work that you do

2.) In your opinion, are the types of injuries typically sustained by birds due to collisions with wind farm structures able to be successfully treated (meaning that they are re-released)?
3.) In your experience, is data regarding bird injuries and fatalities recorded by wind energy facilities, and if so is it easily accessible?
4.) What is your professional opinion regarding wind farms and their impact on birds of prey? How serious of a threat do you think they pose?
5.) What type of solution do you think would be most effective in minimizing the impact of wind farms on birds of prey? (Ex: siting regulations, changes in turbine design and layout; things that can be done before vs. after development)
6.) What motivates you to do the work that you do?

APPENDIX B

List C: Survey Questions

1.) I have read, understood, and printed a copy of, the above consent form and desire of my own free will to participate in this study.
2.) What birds of prey, Species genus, do you typically treat?
3.) What type of injuries do you typically treat in birds of prey? If possible, please select and provide approximate percentages for each type of injury seen.
4.) For the injury types listed, to the extent that you have treated them, what is the typical outcome?
5.) If you selected "Other" in the above questions, please explain. If not, please write N/A.
6.) During what months do you see the most injuries with birds of prey?
7.) To your knowledge, are you located within 100 miles of a wind farm?
8.) In your opinion, when considering the birds of prey that have been brought to your center, could any of the injuries sustained by these birds be attributed to collisions with wind farm infrastructure? (i.e. turbine blades, transmission lines, etc.)
9.) If the answer to the previous question was yes, what percentage of injuries treated do you believe come from collisions due to wind farms?
10.) For wind development projects, would you prefer pre-development mitigation efforts (i.e. siting regulations) or post-development mitigation efforts (i.e. changing existing infrastructure or paying fines)
11.) For wind development projects, would you prefer pre-development mitigation efforts (i.e. siting regulations) or post-development mitigation efforts (i.e. changing existing infrastructure or paying fines)
12.) Consent