Northeast Wind Resource Center

REPORT SUMMARY July 2017

A Summary of

Framework for Testing the Effectiveness of Bat and Eagle Impact-Reduction Strategies at Wind Energy Projects

A report by the National Renewable Energy Laboratory, 2016

Summary prepared by Georgena Terry, Research Associate, CESA[1]

Framework for Testing the Effectiveness of Bat and Eagle Impact - Reduction Strategies at Wind Energy Projects[2] was published in 2016 to help researchers rigorously evaluate their proposed strategies for reducing wind energy related fatalities of bats and eagles. The effects of wind farms on bats and eagles, as well as other wildlife, are difficult to monitor and evaluate, because it is challenging to adequately consider the physical features of wind farms and the ecology of the species they may threaten.

A fatality reduction strategy that has not been carefully crafted may not only fail to protect wildlife, it may unnecessarily reduce the amount of power produced by turbines if the strategy entails reducing or curtailing rotor rotation. Rigorous development and evaluation of a strategy not only reduces species' fatalities, it contributes substantive methodology to others engaged in similar activities.

This report by the National Renewable Energy Laboratory (NREL) discusses the formulation of research questions, experiment design, appropriate field practices, and review and dissemination of report results. The authors argue that a successful study requires a rigorous framework. As used in the report's title, "framework" refers to a formal research method with which the researcher can develop appropriate hypotheses to test so that species are protected with a minimum impact on energy production.

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[1] This summary, prepared by the Clean Energy States Alliance (CESA), was not reviewed by the report's authors.

[2] Karin Sinclair and Elise DeGeorge, 2016. *Framework for Testing the Effectiveness of Bat and Eagle Impact-Reduction Strategies at Wind Energy Projects* (Golden, CO: National Renewable Energy Laboratory, 2016), http://www.nrel.gov/docs/fy16osti/65624.pdf.

Key Findings from the Report

- Wind energy continues to be developed and, with it, the need to understand the effects of wind turbines on wildlife. The authors propose a rigorous approach to understanding these effects.
- Field practices should be developed after making sure wind energy operators are agreeable to having studies done on-site. There may be restrictions on the number of turbines accessible for study. In some cases, permits may be required from state or federal wildlife agencies. Power purchase agreements may even affect the degree to which turbine activity can be modified.
- The feasibility of a study to reduce fatalities depends on the ability to measure the occurrence of those fatalities. Without sufficient "statistical power," it is difficult to propose a treatment, such as using deterrents or feathering a turbine, to reduce fatalities. If the plan is feasible, then the specifics of the test can be developed.
- Crafting the research question properly is critical to the success of the study since it determines the experiment's variables as well as suitable field-testing methods.
- Measuring the species' biological response to wind turbines requires care to avoid measurement error, bias, and uncertainty.
- Researchers can determine the efficacy of a strategy to reduce the likelihood of avian or bat impacts by measuring fatalities. When fatalities of the target species occur infrequently, it may be appropriate for a researcher to measure fatalities of surrogate species with similar behavioral patterns.

Discussion

Simple experiments have shown that raising turbine cut-in speeds, blade feathering, and operational curtailment of rotor rotation may reduce species mortality. However, such changes may reduce energy production or turbine efficiency. Accordingly, wind developers and regulators must be convinced that a proposed wildlife impact reduction strategy will be effective.

A study of a wildlife impact reduction strategy must incorporate statistical protocols which include carefully formulated research questions, consideration of variables which might affect the study, the size and the time scope of the study, and the unit to which modifications are proposed in order to reduce impacts. Typically, the unit is the wind turbine. As a further check on the correctness of the experiment, peer review is recommended before work begins.

Depending on the sites that are the subject of the study, certain requirements may need to be met. Access to the site might be restricted without permits issued by federal, state, or local wildlife agencies. Permits allow researchers to participate in activities that would otherwise be illegal. For example, the U.S. Fish and Wildlife Service issues permits specific to endangered species and migratory birds.

Aside from wildlife permits, there may be restrictions on site access during certain times of the day or the season or during turbine maintenance. If the site is used by farmers or hunters, their actions might add to the complexity of analyzing test results.

The authors use a two-step decision tree analysis to determine the feasibility and design characteristics of field testing an impact reduction strategy. The first step is to determine the feasibility of conducting the proposed impact reduction strategy test. If this step finds frequent target species fatalities, fatalities of appropriate surrogates, or alternative metrics that infer exposure risk, then proceeding to step two is appropriate. This second step examines the study design considerations and recommends a suitable protocol.

Rare fatalities or fatalities that have a low detection rate require the researcher to evaluate the potential to use a surrogate species or an alternative metric. The fatalities of some species, such as golden eagles, Indiana bats, and Hawaiian hoary bats are rare. Large raptors might serve as a surrogate for golden eagles if they respond in similar ways to an impact reduction strategy. Alternative metrics to fatality rates might include analyzing behavior avoidance rates or measuring how many species pass through a study area during a specific time period.

Recommended Methodology for a Study

The research question is the linchpin of the experiment. It is the basis for determining the hypotheses, methods, and variables of the study. The authors cite a sample research question: "At study site X, is the fatality rate of species Y lower at turbines treated with strategy Z than at wind turbines without Z?"

The study site should be representative of the population of species that is being studied. Both temporal and spacial scales should be selected to satisfy the specifics of the study.

The spatial scale of the study site is determined by the species. For instance, if a species of bat experiences more fatalities per turbine per year than golden eagles, then the spacial scale for golden eagles should be larger. A few turbines may be sufficient to draw conclusions about the efficacy of a study of bat fatalities. But a study of golden eagle fatalities might require many turbines or even all the turbines within a wind resource area. The population of species that are sampled at the study site should be representative of the general population in order to confirm the relevance of the findings to other sites.

A temporal scale takes into account the length of the study. Perhaps the research seeks to measure the number of fatalities per megawatt-hour per year, flight paths per hour, or bat calls per hour. The duration of the study should be long enough to accurately measure the variable of interest.

The treatment that will be applied in the experiment is the action undertaken to mitigate fatalities and includes a control treatment in which nothing is done. The effects of the mitigation strategies employed are compared to the control treatment.

The experiment measures a response variable, such as species fatalities or behavior changes that might increase the risk of collision. Examples of measurements might include the number of fatalities that occur per turbine per year or species' responses to a deterrent, such as one that would change the direction of their flight paths.

Additional Considerations

Researchers should be aware of errors and bias that may occur. For example, if the turbines used in a study differ in size, then a size bias can be introduced if the metric is the number of fatalities per turbine. Likewise, if not all carcasses are found in the study area, a measurement bias may be introduced.

Researchers may be misled by misinterpreting the reason for a species' response to a turbine. For example, if the collision rate of a species is influenced more by the structure of a wind turbine than by the movement of its blades, then the number of fatalities per megawatt-hour is not a valid metric.

Field methods, such as using human observers, can also create biases if they have an influence on the variable that is being measured. Humans may not always be present to make observations, limiting the effectiveness of any conclusions based on their observations.

Automated detection systems reduce the need for human observers, but their effectiveness must be borne out by peer-reviewed studies.

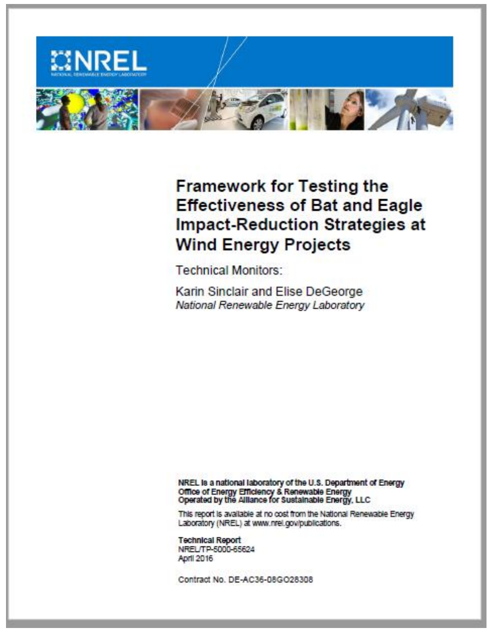
Measuring fatality rates is often subject to error. Perhaps not all carcasses were found during a search. Some may have been removed by predators or some may have landed in an area outside of the defined search area. Even the removal of a carcass by a human may affect results if it changes the behavior of local scavengers. Timing may also have an effect. Species activity, such as migratory movements, may vary with the time of year. Other covariates, such as grass height, topography, rainfall, and others may affect carcass detection.

Some researchers may decide to search a survey area for the purpose of "clearing" it before actual, recorded search periods begin. If all carcasses are not found, this may impact the estimate of fatality rates. Searches may be missed from time to time because of weather or other circumstances. This should be taken into account.

Different strategies may help improve the discovery of carcasses. A slower search over shorter transects will improve results, but that will add to the cost of the search. The use of trained dogs is another strategy, but dogs have their own biases, such as a preference for older carcasses. Ground with shorter vegetation makes carcasses more visible, but also more prone to scavenging. The authors cite a study that discusses the trade-offs among search strategies.

Conclusion

The report concludes that wildlife impact reduction studies designed using the framework should help researchers produce definitive results which can be repeated at similar sites.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The National Renewable Energy Laboratory (NREL) is the only federal laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficient technologies. It is funded through the U.S. Department of Energy.

The lead authors on the report are Karin Sinclair, who currently leads NREL's research portfolio focused on wind energy and wildlife issues for both land-based and offshore wind applications, and Elise DeGeorge, who is the project lead in the wind deployment team and currently leads the Collegiate Wind Competition project.

The report was reviewed by individuals from the Department of Energy, U.S. Geological Survey, Bat Conservation International, and U.S. Fish and Wildlife Service.

The report is available at http://www.nrel.gov/docs/fy16osti/65624.pdf.

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This paper is part of a series by the Northeast Wind Resource Center, a project managed by Clean Energy Group and the Clean Energy States Alliance to provide accessible, concise summaries of technical studies related to land-based wind in the Northeast.

If you have suggestions for studies that should be summarized, please send your suggestions to LBWStaff@northeastwindcenter.org.