Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-294

Proposal Title: Behavioral Response of Bald and Golden Eagles to Acoustic Stimuli

Project Manager Information

Name: Christopher Feist

Organization: U of MN - St. Anthony Falls Laboratory

Office Telephone: (612) 626-0538

Email: feist020@umn.edu

Project Basic Information

Project Summary: The goal of the work is to design and implement an acoustic deterrence protocol that will discourage bald and golden eagles from entering hazardous air space near wind energy installations.

Funds Requested: $307,000

Proposed Project Completion: 2023-06-30

LCCMR Funding Category: Air Quality, Climate Change, and Renewable Energy (E)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Region(s): Central, NE, NW, SW,

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Wind energy is a cost competitive, clean energy source that offers benefits for Minnesota. However, there are some undesirable environmental impacts of wind energy installations; one of primary interest here is federally protected bald and golden eagle collisions with wind turbines resulting in fatalities. A promising method designed to reduce eagle collisions is the installation of acoustic deterrent devices at wind energy installations. In recent years, several studies have attempted to estimate the efficacy of acoustic deterrent systems, but these studies have been conducted in uncontrolled environments with limited data, resulting in a wide range of effectiveness estimates; i.e. estimates of effectiveness on altering flight paths of raptors away from wind turbines range from 7% to 88%. Further, the acoustic stimuli used were developed in the absence of knowledge relating to the hearing attributes of bald and golden eagles. For these devices to be useful as a reliable raptor collision mitigation method, acoustic deterrence developers must have confidence in their effectiveness. This project aims to answer this question under controlled experimental conditions.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

In experiments designed to develop the most effective acoustic deterrent, behavioral responses of bald and golden eagles to a battery of natural and synthetic stimuli will be acquired and analyzed to establish a clear understanding of which stimulus types bald and golden eagles are most responsive to and habituate to the least. A set of prospective deterrence signals will be engineered using the most effective stimuli identified in the behavioral response tests referenced above. Those signals will be used to determine if tethered, but otherwise free-flying birds, respond to deterrence signals by altering customary flight paths. Additional experiments will be conducted by associating prospective sound-based deterrent signals with a visual object to determine if the eagles associate objects with acoustic cues and that those cues might enhance the avoidance behaviors that mitigate the taking of birds at wind energy facilities.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project will provide scientifically rigorous data addressing the effectiveness of acoustic deterrence signals to alter the flight path of eagles and therefore mitigate the fatality rate associated with wind turbine collisions. The project will identify and design acoustic deterrence signals that have been tested under controlled experimental conditions with both bald and golden eagles. Findings from this study will provide system designers and developers alike a solid foundation upon which to implement acoustic deterrence technologies.

Activities and Milestones

Activity 1: Behavioral testing of perched bald and golden eagles to potential acoustic deterrence signals

Activity Budget: $170,000

Activity Description:
In this activity, the team will build on work recently concluded as part of a U.S. Department of Energy (DOE) funded project. In phase one of that study, the auditory attributes of bald and golden eagles were investigated. In a second study, a subset of calls from the vocal repertoire of bald and golden eagles were acoustically analyzed, and in a third preliminary data associated with behavioral responses of 3 bald eagles to a collection of natural and synthetic acoustic stimuli in a laboratory setting were acquired and analyzed.

In the first activity of the proposed study, our goal is to expand the small sample sizes used in the preliminary study to include 10 bald and 10 golden eagles in an effort to identify the most effective alerting acoustic stimuli and to which there is little, if any, habituation. Using this information, acoustic deterrence signals will be developed and used in tests specified in activities 2 and 3. Bald eagles will be tested at the University of Minnesota Raptor Center and golden eagles will be tested in Cyril, OK at Sia: The Comanche Nation Ethno-Ornithological Initiative.

Activity Milestones:

Description	Completion Date
Engineer prospective acoustic deterrent stimuli for activities 2 and 3	2021-10-31
Complete bald eagle behavioral response testing	2021-11-30
Complete analysis of bald eagle behavioral responses to acoustic stimuli	2021-12-31
Complete golden eagle behavioral response testing	2022-01-31
Complete analysis of golden eagle behavioral response to acoustic stimuli	2022-04-30
Activity 1 summary report	2022-05-31

Activity 2: Phase 1 behavioral testing of bald eagles to potential acoustic deterrent signals during tethered flight

Activity Budget: $65,000

Activity Description:
The objective of activity 2 is to measure the effectiveness of acoustic deterrence signals developed in activity 1 to alter the flight path of eagles during tethered flight. Testing in this phase of the project will take place with wild bald eagles that are being rehabilitated at The University of Minnesota Raptor Center. To evaluate the effectiveness of acoustic deterrence signals to alter the flight path of eagles, 10 individuals will be evaluated during this phase of the investigation. Individual eagles will be evaluated multiple times on different days to assess habituation tendencies. By the end of the project, as many as 1200 flights, or more, will have been logged. Half of these flights will have included an acoustic deterrence element and half will not. Analyzing data collected during these flights using tracking sensors (GPS tags) attached to the birds will permit the objective assessment of the acoustic deterrence strategy.

Activity Milestones:

Description	Completion Date
Develop data acquisition system	2021-10-31
Complete analysis of tethered flight trial data	2022-05-31
Complete bald eagle tethered flight trials	2022-05-31

Activity 2 summary report	2022-06-30

Activity 3: Phase 2 behavioral testing of bald eagles to potential acoustic deterrent signals during tethered flight

Activity Budget: $72,000

Activity Description:
Activity 3 will expand tethered flight testing into a second season. Tethered flight exercise associated with the Center's rehabilitation program typically occurs during the months of October through December in preparation for the bird's release into the wintering population of wild eagles. A second phase of testing will allow refinement of the testing procedure and concentration on acoustic stimuli shown in the earlier phases of this study to be most effective. We will also assess the combined influence of the presence of a structure and the broadcast of deterrence signals, as well as the influence of each element in isolation. Field testing of acoustic deterrence systems at wind farms have indicated some positive association between the noise deterrent and wind turbines.

Activity Milestones:

Description	Completion Date
Modify tethered flight procedure and acoustic stimuli	2022-08-31
Complete tethered flight trials	2022-12-31
Complete analysis of flight response data	2023-03-31
Activity 3 summary report	2023-04-30
Final project report	2023-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jeffrey Marr	St. Anthony Falls Laboratory, University of Minnesota	Jeff Marr will serve as a co-investigator and assist with project management and research dissemination.	Yes
Julia Ponder	The Raptor Center, University of Minnesota	Julia Ponder will serve as a co-investigator and provide expertise on raptor behavior, design of laboratory testing, animal care protocols, and permitting requirements.	Yes
Lori Arent	The Raptor Center, University of Minnesota	Lori Arent will assist in the design of laboratory testing, be responsible for access to test subjects, animal care protocols and permitting requirements, and lead tethered flights of bald eagles.	Yes
JoAnn McGee	VA Loma Linda Healthcare System	JoAnn will serve as a lead research scientist on the project with responsibilities including developing acoustic stimuli, design of laboratory testing, and analysis of behavioral response test data.	Yes
Edward Walsh	VA Loma Linda Healthcare System	Ed will serve as a lead research scientist on the project with responsibilities including developing acoustic stimuli, design of laboratory testing, and analysis of behavioral response test data.	Yes
Christopher Milliren	St. Anthony Falls Laboratory, University of Minnesota	Chris Milliren will provide technical support and develop the sensor systems used in the behavioral response and tethered flight testing.	Yes
Peggy Nelson	Speech-Language-Hearing Science, University of Minnesota	Peggy will serve as a co-investigator and assist in the design of behavioral response testing.	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

Results of the project will be communicated with the wind industry and other stakeholders via conferences, journal articles, reports, and direct communication with wind industry partners. The impact of this project will influence strategic planning activities of primary wind energy stakeholders as they develop the next generation of environment friendly technologies. The US Department of Energy and the American Wind Wildlife Institute are committed to reducing the environmental impacts of wind energy and fund research aimed at this goal. Proposals for funding additional work can be submitted to these sources, as well as by establishing partnerships with private energy companies.

Project Manager and Organization Qualifications

Project Manager Name: Christopher Feist

Job Title: Associate Engineer

Provide description of the project manager's qualifications to manage the proposed project.
Christopher Feist is a research engineer at the St. Anthony Falls Laboratory (SAFL), University of Minnesota (UMN). He received both his BS in aerospace engineering (2011) and MS in civil engineering (2015) from the University of Minnesota. Mr. Feist has worked at SAFL since 2009 and during that time has worked as an engineer on a broad range of projects in the fields of hydro-kinetic energy, wind energy, hydraulic engineering, and acoustics. His research interests are broad and include improving the efficiency and reducing the environmental impacts of renewable energy systems. He has managed multiple research projects in the wind energy field including a US Department of Energy project on golden and bald eagle hearing. A few standout projects Mr. Feist has managed are: a multi-year, interdisciplinary research project on wind turbine noise and the human response funded by Xcel Energy Renewable Development Fund (RDF); structural health monitoring system development for wind turbine foundations funded by Xcel Energy RDF; and a US Department of Energy project aiming to quantify golden and bald eagle hearing thresholds and a pilot study on the behavioral response to acoustic stimuli.

Organization: U of MN - St. Anthony Falls Laboratory

Organization Description:
The St. Anthony Falls Laboratory (SAFL) is a university research laboratory dedicated to environmental fluid mechanics and understanding and reducing environment impacts. For over a decade SAFL has been involved in wind energy research. Recently, SAFL partnered with the Raptor Center and auditory specialists on a US Department of energy project which mapped the hearing frequency range and thresholds of golden and bald eagles and red-tailed hawks, a first step in developing acoustic deterrents to help prevent bird takes at wind farms. With this unique partnership, researchers in the field of wind energy and scientists with expertise in the areas of auditory physiology and behavior gained access to rehabilitating wild raptors, particularly bald and golden eagles, to measure hearing abilities and begin working to understand their behavioral responses to potential acoustic deterrence signals. In this project, we plan to leverage the same team to further study the behavioral responses of bald and golden eagles, including during tethered flight, to acoustic signals intended to prevent collisions with wind turbines.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Christopher Feist		PI			27%	0.4		$34,158
Jeffrey Marr		Co PI			27%	0.02		$4,048
Christopher Milliren		Engineer			24%	0.48		$34,800
Benjamin Erickson		Scientist			24%	0.16		$12,898
Peggy Nelson		Co PI			27%	0.06		$13,956
Julia Ponder		Co PI			27%	0.08		$16,443
Lori Arent		Scientist - Bird Handling			27%	0.24		$21,257
Technician		Veterinarian Technician - Animal Care			24%	0.18		$9,432
							Sub Total	**$146,992**
Contracts and Services								
Ed Walsh and JoAnn McGee	Professional or Technical Service Contract	Ed and JoAnn will serve as lead researchers on the project. They bring expertise in experimental design, data analysis, and animal bio-acoustics.				1		$144,000
							Sub Total	**$144,000**
Equipment, Tools, and Supplies								
	Equipment	Speakers	Speakers used in tethered flight testing to emit acoustic stimuli					$4,000
	Equipment	Audio Equipment	Amplifiers and signal generators for use in the tethered flight testing					$2,000
	Equipment	RTK GPS tracking	Tracking device system to measure the flight path of bald eagles during tethered flights					$3,000
	Equipment	Tethered flight materials	Equipment used in tethered flights of bald eagles such as harness, gauntlets, creance line, etc.					$1,675

							Sub Total	**$10,675**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel costs to tethered flights location for team members	Reimbursement for travel to eagle tethered flight location					$478
							Sub Total	**$478**
Travel Outside Minnesota								
	Miles/ Meals/ Lodging	Expenses ascociated with travel to Cyril, OK for team members for 5 days	Travel to Cyril, OK for behavioral response testing of golden eagles	X				$4,855
							Sub Total	**$4,855**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$307,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Miles/Meals/Lodging	Expenses ascociated with travel to Cyril, OK for team members for 5 days	The Sia organization has golden eagles available for behavioral response testing. Golden eagles are rare in MN and therefore the University of Minnesota Raptor Center will likely not have rehabilitating golden eagles available for research.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	Unrecovered F&A	Support of SAFL facilities where research will be conducted.	Secured	$168,850
			Non State Sub Total	**$168,850**
			Funds Total	**$168,850**

Attachments

Required Attachments

Visual Component

File: 4f8fffc1-b7b.pdf

Alternate Text for Visual Component

The visual shows two of the experimental setups planned for the project. One figure shows a bald eagle in an indoor pen at the Raptor Center where behavioral testing to acoustic stimuli is occurring, image is from a previous DOE funded study. Speakers are located on either side of the eagle and researchers are monitoring/controlling the test from a remote location using video. The second figure shows an experimental setup with a bald eagle flying down a corridor with speakers on either side. This demonstrates the setup during the tethered flight trials where we plan to measure alterations in flight path due to the presence of acoustic deterrence signals.

Optional Attachments

Support Letter or Other

Title	File
Proposal endorsement - UMN	bfa95df9-195.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

Yes

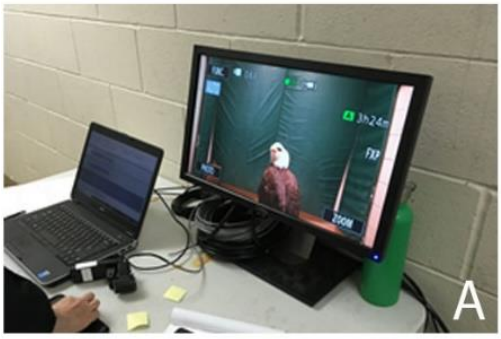
Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

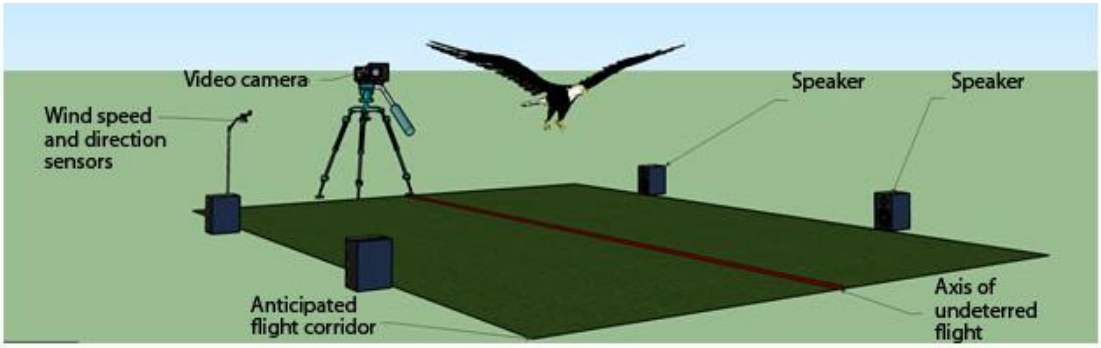
BEHAVIORAL RESPONSE OF BALD AND GOLDEN EAGLES TO ACOUSTIC STIMULI

PRINCIPAL INVESTIGATOR: CHRISTOPER FEIST, ST. ANTHONY FALLS LAB - UMN

Reducing the risk of eagle fatalities from wind energy by developing and testing an acoustic deterrence protocol



- Bald and golden eagles are protected by federal law under the *Bald and Golden Eagle Protection Act*
- Wind Energy is a cost competitive and clean energy source that offers clear benefits to Minnesota, but poses a risk to bald and golden eagles
- Acoustic stimuli has been suggested as a way to alert eagles to the presence of wind turbines and alter their flight paths away from hazardous airspace
- Currently available acoustic deterrent technologies have been shown to be between 7% and 88% effective, but were developed in the absence of knowledge related to the hearing attributes of bald and golden eagles – **We believe that we can improve effectiveness through a scientifically rigorous series of behavioral tests**



- We propose to leverage our previous work on the hearing characteristics of bald and golden eagles to develop and test and acoustic deterrence protocol in controlled environments
- To accomplish this we have assembled a highly specialized, interdisciplinary research team consisting of wind energy experts, veterinarians from the world-renowned University of Minnesota Raptor Center, and scientists specializing in auditory neuroscience and bioacoustics