



Fort Collins Science Center

Bat Fatalities at Wind Turbines— Investigating the Causes and Consequences

Wind energy is one of the fastest-growing industries in the world and represents an important step toward reducing dependence on nonrenewable sources of power. However, widespread deployment of industrial wind turbines is having unprecedented adverse effects on certain species of bats that roost in trees and migrate. Bats are beneficial consumers of agricultural insect pests and migratory species of bats provide free pest-suppression services across ecosystems and international borders.



Although the underlying causes of bat fatalities at wind turbines remain unknown, potential clues can be found in the patterns of fatalities. TSH scientists, in collaboration with other U.S. Geological Survey (USGS) science centers as well as partners from Federal, State, and non-governmental organizations, are using these clues to focus research efforts. Investigations are underway to better identify the seasonal distributions, habitat needs, and migration patterns of species showing greatest

Status - Active

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Two wind turbines from the side on clear day. Public domain.

susceptibility, assess the potential roles of mating and feeding behaviors in turbine collisions,

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develop new video-based methods for studying and monitoring bats flying around wind turbines at night, and test whether bats are attracted to turbines. Findings from these studies are leading us toward new ways of monitoring and possibly avoiding bat fatalities at wind turbines.

Bats are being found dead beneath wind turbines all over the world. Bat fatalities have now been documented at most wind facilities in the U.S. and Canada and it is estimated that tens to hundreds of thousands die at wind turbines in North America each year. This fairly new and unanticipated problem has [moved to the forefront of conservation and management efforts](#) directed toward this poorly understood group of mammals, particularly due to the concurrent effects of a new bat disease, [white-nose syndrome](#). The mystery of why bats die at industrial wind turbines remains unsolved. Is it a simple case of flying in the wrong place at the wrong time? Are bats attracted to the spinning turbine blades? Why are so many bats colliding with turbines compared to their infrequent crashes with other tall, human-made structures? Are there ways to predict and minimize risk to bats before turbines are built?

[Although these questions remain mostly unanswered, potential clues can be found in the patterns of fatalities.](#) Foremost, the majority of bat fatalities at industrial turbines are species that migrate long distances and rely on trees as roosts throughout the year, some of which migrate long distances; we call these “tree bats.” Tree bats compose more than three quarters of the bat fatalities observed at wind energy sites. The other striking pattern is that the vast majority of bat fatalities at wind turbines occur during late summer and autumn. This [seasonal peak in fatalities coincides with](#) periods of both autumn migration, mating, and possibly increased feeding behavior by tree bats. Seasonal involvement of species with shared behaviors indicates that behavior plays a key role in the susceptibility of bats to wind turbines, and that migratory tree bats might actually be attracted to turbines.

Over the past decade USGS scientists and their research partners have been studying bat deaths at wind turbines, with the ultimate goal of understanding why they are happening so solutions can be developed to avoid or fix the problem. In addition to synthesizing existing information, USGS research has focused on better understanding aspects of tree bat ecology that might offer important clues to their susceptibility. This work has shed new light on the [migratory movements, mating behaviors, and feeding habits](#) of migratory tree bats, which may help explain their disproportionate representation among turbine fatalities. For example, recent [analysis of distribution records](#) hints at where these bats might occur at any given time of year.

Continuing on the same research trajectory, USGS scientists at the Fort Collins Science Center have built an active research program to investigate the causes and consequences of bat fatalities at wind turbines. In collaboration with scientists at four other USGS science centers, as well as universities and conservation organizations, our specific focus is to better identify the [seasonal distributions, habitat needs, and migration patterns](#) of species showing greatest susceptibility, continue to [assess the potential roles of mating and feeding behaviors](#) in turbine collisions, [develop new video-based methods](#) for studying and monitoring bats and birds flying around wind

turbines at night, and find new and efficient ways of preventing bat deaths at wind turbines. USGS is now [experimentally determining](#) whether bat activity and fatality can be minimized or avoided by changing how [bats perceive](#) wind turbines from afar. With a proven track record of studying bat migration and behavior, combined with an existing infrastructure that promotes collaboration between disciplines, the USGS is well-equipped to effectively address the problem of bat mortality at wind power facilities. Only through further focused research will we efficiently make progress toward minimizing the impact of this new form of sustainable energy on our Nation's wildlife.



Wind turbines and a rainbow towering high above trees on an island in Hawaii. Photo by: Paul Cryan, USGS. Public domain.

Return to [The New Mexico Landscapes Field Station](#) or [Ecosystem Dynamics](#)

or

Return to [Species Conservation](#) or [Trust Species and Habitats](#)

Below are other science projects associated with this project.



Date published: OCTOBER 26, 2016

Status: Active

[North American Bat Monitoring Program \(NABat\)](#)

North American bats face unprecedented threats including habitat loss and fragmentation, white-nose syndrome, wind energy development, and climate change. However, it is difficult to evaluate the impacts of these threats due to a lack of basic information about the distribution and abundance of bats across the continent. Although bat monitoring has long been conducted in individual areas and...

Contacts: [Brian Reichert, Ph.D.](#), [Bethany Straw](#), [Kathi Irvine, Ph.D.](#), [Wayne E Thogmartin, Ph.D.](#), [W. Mark Ford, Ph.D.](#), [Paul Cryan, Ph.D.](#)

Attribution: Energy & Wildlife, Invasive Species Program, Fort Collins Science Center, Northern Rocky Mountain Science Center



Date published: SEPTEMBER 23, 2016

Status: Active

The New Mexico Landscapes Field Station

The New Mexico Landscapes Field Station is a place-based, globally-connected, ecological research group that studies and interprets ecosystem and wildlife dynamics, working with land managers and community leaders to deliver solutions that foster the linked health of human and natural systems.

Our partnerships, and co-location, with land management agencies provide us with opportunities...

Contacts: [Ernie Valdez, Ph.D.](#), [Ellis Q Margolis, Ph.D.](#), Kay Beeley, Manuel Lopez
Attribution: Ecosystems, Region 7: Upper Colorado Basin, Fort Collins Science Center



Date published: JULY 5, 2016

Status: Active

Bat Species of Concern: An Ecological Synthesis for Resource Managers

A large number of bat species are considered “species of concern” in the United States and its Territories, and resource managers are increasingly interested in learning more about their distribution, status, and potential management.

Contacts: [Paul Cryan, Ph.D.](#)

Attribution: Ecosystems, Invasive Species Program, Wildlife Program, Region 7: Upper Colorado Basin, Fort Collins Science Center

Below are publications associated with this project.



Year Published: 2016

First direct evidence of long-distance seasonal movements and hibernation in a migratory bat

Understanding of migration in small bats has been constrained by limitations of techniques that were labor-intensive, provided coarse levels of resolution, or were limited to population-level inferences. Knowledge of movements and behaviors of individual bats have been unknowable because of limitations in size of tracking devices and methods to...

Weller, Theodore J.; Castle, Kevin T.; Liechti, Felix; Hein, Cris D.; Schirmacher, Michael R.; Cryan, Paul M.

Attribution: [Fort Collins Science Center, Ecosystems, Energy & Wildlife, United States of America](#)



Year Published: 2016

Evaluating the effectiveness of wildlife detection and observation technologies at a solar power tower facility

Solar power towers produce electrical energy from sunlight at an industrial scale. Little is known about the effects of this technology on flying animals and few methods exist for automatically detecting or observing wildlife at solar towers and other tall anthropogenic structures. Smoking objects are sometimes observed co-occurring with reflected...

Diehl, Robert H.; Valdez, Ernest W.; Preston, Todd M.; Wellik, Mike J.; Cryan, Paul M.
Attribution: [Biology and Ecosystems, Northern Rocky Mountain Science Center, Ecosystems, Energy & Wildlife, , United States of America](#)

[View Citation](#) ✓



Year Published: 2016

Multiple mortality events in bats: a global review

Despite conservation concerns for many species of bats, factors causing mortality in bats have not been reviewed since 1970. Here, we review and qualitatively describe trends in the occurrence and apparent causes of multiple mortality events (MMEs) in bats around the world. We compiled a database of MMEs, defined as cases in which \geq ...

O'Shea, Thomas J.; Cryan, Paul M.; Hayman, David TH; Plowright, Raina K.; Streicker, Daniel G.

Attribution: [Fort Collins Science Center, Ecosystems, Energy & Wildlife, United States of America](#)

[View Citation](#) ✓



Year Published: 2015

Dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat *Lasiurus cinereus semotus*

Widespread bat fatalities at industrial wind turbines are a conservation issue with the potential to inhibit efficient use of an abundant source of energy. Bat fatalities can be reduced by altering turbine operations, but such curtailment decreases turbine efficiency. If additional ways of reducing bat fatalities at wind turbines were available...

Gorresen, P. Marcos; Cryan, Paul M.; Dalton, David C.; Wolf, Sandy; Johnson, Jessica A.; Todd, Christopher M.; Bonaccorso, Frank J.

Attribution: [Fort Collins Science Center, Pacific Island Ecosystems Research Center, Ecosystems, Energy & Wildlife, , Hawaii, United States of America](#)

[View Citation](#) ✓



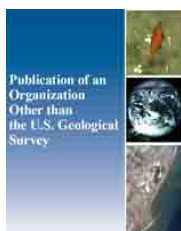
Year Published: 2015

Ultraviolet vision may be widespread in bats

Insectivorous bats are well known for their abilities to find and pursue flying insect prey at close range using echolocation, but they also rely heavily on vision. For example, at night bats use vision to orient across landscapes, avoid large obstacles, and locate roosts. Although lacking sharp visual acuity, the eyes of bats evolved to function...

Gorresen, P. Marcos; Cryan, Paul M.; Dalton, David C.; Wolf, Sandy; Bonaccorso, Frank
Attribution: [Pacific Island Ecosystems Research Center](#), [Ecosystems](#)

[View Citation](#) ✓



Year Published: 2015

Seasonally-dynamic presence-only species distribution models for a cryptic migratory bat impacted by wind energy development

Understanding seasonal distribution and movement patterns of animals that migrate long distances is an essential part of monitoring and conserving their populations. Compared to migratory birds and other more conspicuous migrants, we know very little about the movement patterns of many migratory bats. Hoary bats (*Lasiurus cinereus*), a cryptic,...

Hayes, Mark A.; Cryan, Paul M.; Wunder, Michael B.
Attribution: [Biology and Ecosystems](#), [Fort Collins Science Center](#), [Ecosystems](#), [Energy & Wildlife](#), [Status and Trends Program](#), [United States of America](#)

[View Citation](#) ✓



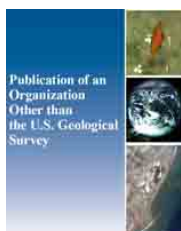
Year Published: 2015

Not to put too fine a point on it - does increasing precision of geographic referencing improve species distribution models for a wide-ranging migratory bat?

Bat specimens held in natural history museum collections can provide insights into the distribution of species. However, there are several important sources of spatial error associated with natural history specimens that may influence the analysis and mapping of bat species distributions. We analyzed the importance of geographic referencing and...

Hayes, Mark A.; Ozenberger, Katharine; Cryan, Paul M.; Wunder, Michael B.
Attribution: [Fort Collins Science Center](#), [Ecosystems](#), [Energy & Wildlife](#), [United States of America](#)

[View Citation](#) ✓



Year Published: 2015

Using sutures to attach miniature tracking tags to small bats for multimonh movement and behavioral studies

1. Determining the detailed movements of individual animals often requires them to carry tracking devices, but tracking broad-scale movement of small bats (< 30g) has been

limited by transmitter technology and long-term attachment methods. This limitation inhibits our understanding of bat dispersal and migration, particularly in the context of...

Castle, Kevin T.; Weller, Theodore J.; Cryan, Paul M.; Hein, Cris D.; Schirmacher, Michael R.

Attribution: [Fort Collins Science Center, Ecosystems, Energy & Wildlife, United States of America](#)

[View Citation](#) ✓



Year Published: 2014

Watching the dark: New surveillance cameras are changing bat research

It is, according to an old proverb, “better to light a candle than to curse the darkness.” And those of us trying to discover new insights into the mysterious lives of bats often do a lot of cursing in the darkness. Bats do most things under cover of night, and often in places where humans and most other animals can’t go. This dark inaccessibility...

Cryan, Paul M.; Gorresen, P. Marcos

Attribution: [Fort Collins Science Center, Ecosystems](#)

[View Citation](#) ✓



Year Published: 2014

Behavior of bats at wind turbines

Wind turbines are causing unprecedented numbers of bat fatalities. Many fatalities involve tree-roosting bats, but reasons for this higher susceptibility remain unknown. To better understand behaviors associated with risk, we monitored bats at three experimentally manipulated wind turbines in Indiana, United States, from July 29 to October 1, 2012...

Cryan, Paul M.; Gorresen, P. Marcos; Hine, Cris D.; Schirmacher, Michael; Diehl, Robert H.; Huso, Manuela M.; Hayman, David T.S.; Fricker, Paul D.; Bonaccorso, Frank J.; Johnson, Douglas H.; Heist, Kevin W.; Dalton, David C.

Attribution: [Biology and Ecosystems, Forest and Rangeland Ecosystem Science Center, Fort Collins Science Center, Pacific Island Ecosystems Research Center, Ecosystems, Energy & Wildlife, United States of America](#)

[View Citation](#) ✓



Year Published: 2014

Continental-scale, seasonal movements of a heterothermic migratory tree bat

Long-distance migration evolved independently in bats and unique migration behaviors are likely, but because of their cryptic lifestyles, many details remain unknown. North American hoary bats (*Lasiurus cinereus cinereus*) roost in trees year-round and probably migrate farther than any other bats, yet we still lack basic information about their...

Cryan, Paul M.; Stricker, Craig A.; Wunder, Michael B.

Attribution: [Fort Collins Science Center, Ecosystems, Energy & Wildlife, United States of America](#)

[View Citation](#) ✓



Year Published: 2014

Market forces and technological substitutes cause fluctuations in the value of bat pest-control services for cotton

Critics of the market-based, ecosystem services approach to biodiversity conservation worry that volatile market conditions and technological substitutes will diminish the value of ecosystem services and obviate the “economic benefits” arguments for conservation. To explore the effects of market forces and substitutes on service values, we...

López-Hoffman, Laura; Wiederholt, Ruscena; Sansone, Chris; Bagstad, Kenneth J.; Cryan, Paul M.; Diffendorfer, James E.; Goldstein, Joshua; LaSharr, Kelsie; Loomis, John; McCracken, Gary; Medellín, Rodrigo A.; Russell, Amy; Semmens, Darius J.

Attribution: [Geosciences and Environmental Change Science Center, John Wesley Powell Center for Analysis and Synthesis, Energy & Wildlife, Groundwater and Streamflow Information Program, Region 7: Upper Colorado Basin, United States of America, John Wesley Powell Center for Analysis and Synthesis](#)

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