Guidelines
for Conservation Siting of Energy Infrastructure in Missouri

PREPARED BY THE MISSOURI ENERGY INFRASTRUCTURE CONSERVATION SITING WORK GROUP

GUIDELINES FOR CONSERVATION SITING OF ENERGY INFRASTRUCTURE IN MISSOURI

Prepared by the Missouri Energy Infrastructure Conservation Siting Work Group

April 2022
Version 1.0

The Missouri Energy Infrastructure Conservation Siting Work Group was formed in 2019 with the endorsement of the Natural Resources Subcommittee (Chair, Carol Davit) of the Missouri OAKS Committee (Outdoor Action Committee, Chair, Kelly Srigley-Werner) to develop these Energy Infrastructure Conservation Siting Guidelines, incorporating and expanding previous work done by Burroughs Audubon on Wind Energy Siting Guidelines.

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This guide and other resources can be found at:
http://www.moguidelines.net

SUPPORTING ORGANIZATIONS:

Bat Conservation International
Bridging the Gap
Burroughs Audubon Society of Greater Kansas City
Columbia Audubon Society
Conservation Federation of Missouri
Ducks Unlimited
Greater Ozark Audubon Society
Great Rivers Environmental Law Center
L-A-D Foundation
Midland Empire Audubon
Missouri Birding Society
Missouri Chapter of The Nature Conservancy
Missouri Native Plant Society
Missouri Parks Association
Missouri Prairie Foundation
Missouri River Bird Observatory
Monarch Watch
Platte Land Trust
Powell Gardens
Shaw Nature Reserve
Sierra Club - Missouri
Springfield Plateau Chapter - Missouri Master Naturalists
St. Louis Audubon

This publication was made possible by Burroughs Audubon Society of Greater Kansas City through an Audubon In Action grant.

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INTRODUCTION

The goal of these guidelines is to provide a statewide framework for wind and solar energy infrastructure development in Missouri while minimizing negative impacts of this development to Missouri's priority conservation landscapes.

These priority conservation landscapes contain some of the state's largest and most important natural areas, Landscape Conservation Opportunity Areas, remnant landscapes, native biodiversity, bat hibernacula, and Important Bird Areas. Meaningful consultation with United States Fish and Wildlife Service (USFWS), Missouri Department of Conservation (MDC), other key stakeholders, and use of relevant siting tools such as The Nature Conservancy's **Site Renewables Right tool** to identify Missouri's priority conservation landscapes are critical first steps in planning.

Site Renewables Right tool:
https://www.nature.org/en-us/what-we-do/our-priorities/tackle-climate-change/climate-change-stories/site-wind-right/

These guidelines are voluntary and are intended for policy makers, law makers, community planners, energy and conservation professionals, and citizens to use as a guide for optimal siting of energy infrastructure to address conservation concerns in siting energy projects. Not all recommendations herein will be applicable for all sites or projects and should be evaluated on a site- and project-specific basis. The scope of these guidelines is not all inclusive, and specific recommendations, not included in this document, may be made on a project- or site-specific basis.

These guidelines also include conservation siting considerations for pipelines and energy transmission infrastructure.

This document has three components:

I. Guidelines for Wind Energy Infrastructure Conservation Siting

II. Guidelines for Solar Energy Infrastructure Conservation Siting

III. Guidelines for Pipeline and Transmission Infrastructure Conservation Siting

I. GUIDELINES FOR CONSERVATION SITING OF WIND ENERGY INFRASTRUCTURE

The purpose of the following guidelines is to inform and guide wind energy infrastructure developers, operators, community planners, and other stakeholders to voluntarily site, construct, and operate the infrastructure in ways that minimize impacts to Missouri's priority conservation landscapes. (See also Section III, Guidelines for Pipeline and Transmission Infrastructure Conservation Siting, because transmission lines facilitate wind energy development.)

Summary

In 2019, Missouri generated 73% of its electricity from coal, burning more than any other state after Texas and Indiana (U.S. Energy Administration). At the same time, wind generation is blossoming. Missouri ranked 20th in the nation in installed wind capacity in 2019, and this capacity was predicted to double within a year (American Wind Energy Association). Public health, the health of the climate, and the protection of native biodiversity depend on the replacement of coal-generated energy with wind and solar electricity. The mission of renewable energy is not only to provide electricity but also to do so consistently with the preservation of the diminishing natural world.

Wildlife and ecosystems benefit from the reduction of fossil fuel usage. The most recent National Audubon Society report on climate change showed two-thirds (389 out of 604) of North American bird species are at risk of extinction from climate change (Bateman et al. 2020). In 2011 (updated November 2015), the National Wildlife Federation issued a report, Game Changers: Air Pollution, a Warming Climate, and the Troubled Future for America's Hunting and Fishing Heritage, on climate change that points to significant consequences for hunters and anglers, who contribute $90 billion to our national economy annually.

Renewable energy plays an increasingly important role in meeting the energy demands of Missouri residents while reducing carbon dioxide emissions resulting from the burning of fossil fuels. Missourians benefit from the development of renewable energy, including wind energy, when the planning and siting process minimizes the impact to priority conservation landscapes.

1. Introduction and the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines

The foremost guidance on wind project placement for wildlife is the **U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines**. The tiered approach in these guidelines outlines the first steps that should be taken for wind energy development in Missouri along with compliance with any state, county, or other local regulations.

U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines:
https://www.fws.gov/sites/default/files/documents/land-based-wind-energy-guidelines.pdf

The Guidelines for Conservation Siting of Wind Energy Infrastructure contained in this document are meant to supplement the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines and recommendations made by USFWS, MDC, and other conservation stakeholders, as well as state and local regulations, during the proposed project review process.

2. Preserving Wildlife: Design, Construction, and Operation Measures to Minimize Wildlife Impact

Efforts to ensure proper, initial siting will avoid more costly measures such as curtailment and mitigation.

Photo: Mary Nemecek

Birds

Missouri hosts more than 300 species of birds as year-round residents, seasonal residents, and for stop-over habitat during migration. Included among these are several species designated as federally or state endangered or threatened birds.

Many of the priority conservation landscapes house or lie within Important Bird Areas (IBA). The National Audubon Society has designated 47 IBAs, including five that are recognized as Globally Important Bird Areas. Four priority designations have been given to Missouri IBAs by Audubon. These four are:

- Grasslands and Prairie IBAs — including Grand River Grassland, Cole Camp Prairies, and Golden Grasslands
- Iatan/Weston Bend River Corridor IBA
- Great Rivers Confluence IBA
- White River Glades and Woodlands IBA

Proper siting of wind energy projects can both help offset the environmental impact of fossil fuels and reduce ecological pressure on native fauna. Improper siting of wind energy projects can negatively impact wildlife, including the birds and bats that live in and migrate through Missouri.

Protecting Missouri's priority conservation landscapes should include:

» Avoiding improper siting of turbines or transmission lines near:

- migratory flyways
- stopovers such as wetlands, grasslands, forests, conservation areas, and lakes
- geological features such as ridges, rivers, and bluffs

» Decreasing potential predation of song and ground-dwelling birds by raptors due to the installment of structures that can be used as perches in grasslands

» Preventing fragmentation of habitat due to turbine installment and access roads

» Reducing degradation of habitat due to construction, installment of roads, dust from roads that coats vegetation, and introduction of invasive plants

- Invasive plants can be transported into an area on vehicles, tires, mower blades, clothing, etc.
- Invasive plants can quickly establish on bare ground that is not immediately replanted with seed of native plants appropriate to the area or otherwise managed to avoid invasive species being moved into the area.

Photo: Jim Kennedy

Bats

Proper project siting is the most efficient way to rapidly deploy wind projects in Missouri. Conserving sensitive bat species may also include the need for curtailment. Permitting impacts to federally listed species can be a costly and lengthy effort.

Missouri lists 16 species of bats, including: three federally endangered (Indiana bat, gray bat, and Ozark big-eared bat – now extirpated); one federally threatened (northern long-eared bat); two petitioned for federal listing (little brown bat and tricolored bat); an additional seven as Missouri Species of Conservation Concern; and three common species.

Bats are especially vulnerable to collisions with wind turbines, although the reasons are not fully understood. It is estimated that approximately 600,000 to 888,000 bats were killed by wind turbines in the United States in 2012 (Hayes 2013 & Smallwood 2013). Based on industry data provided by the Renewable Energy Wildlife Institute (REWI), the median number of fatalities in the Midwest at wind facilities through 2018 was approximately 6.2 (range 0.4 – 32.0) bats per megawatt (MW) installed (REWI 2018). This median value was the highest among regions in the United States.

The majority (72%) of bat fatalities referenced in the 2018 REWI study were migratory tree bats, which includes two Missouri Species of Conservation Concern (hoary bat and silver-haired bat).

Preliminary siting steps should include review of The Nature Conservancy's **Site Renewables Right tool** for Missouri (see *Page 4* for link). Follow-up with USFWS and MDC regarding protected and sensitive species in specific target development areas can help to identify and avoid areas with known conflicts. For example, MDC provides information about species occurrences through the **Missouri Natural Heritage Review website** and other resources to show areas of enhanced risk (for instance, see *Figures 1 & 2* for Indiana bat).

Missouri Natural Heritage Review website:
https://naturalheritagereview.mdc.mo.gov/

A key permitting efficiency in time and cost is for Missouri wind projects to utilize the USFWS template for **Midwest Short-term Habitat Conservation Plans (HCP)**.

Midwest Short-term HCP Template:
https://fws.gov/media/midwest-short-term-hcp-template

Wind projects that cannot remain at or below the specified take levels could anticipate a lengthy permitting process before power can be supplied to the grid. Additionally, high take levels from one project may hamper future projects because of the finite allowable "take" of endangered species within a species management unit.

A collaborative process with all partners and stakeholders will result in the best outcome for renewable energy development and proper siting for wildlife.

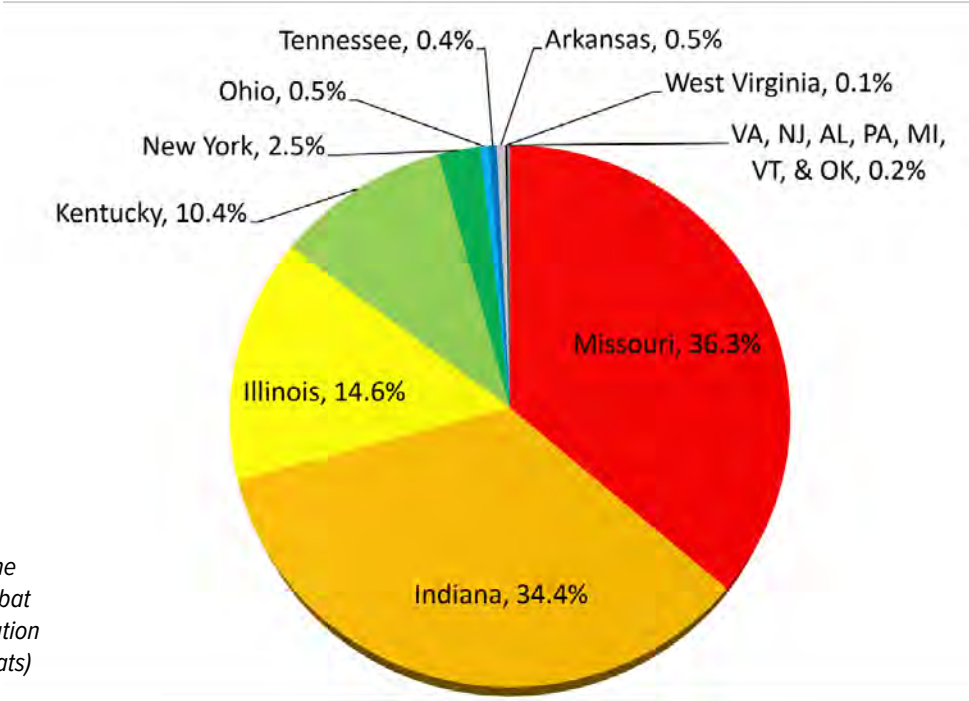


Figure 1. *Percentage of the 2019 range-wide Indiana bat population during hibernation (approximately 537,297 bats) within each state.*

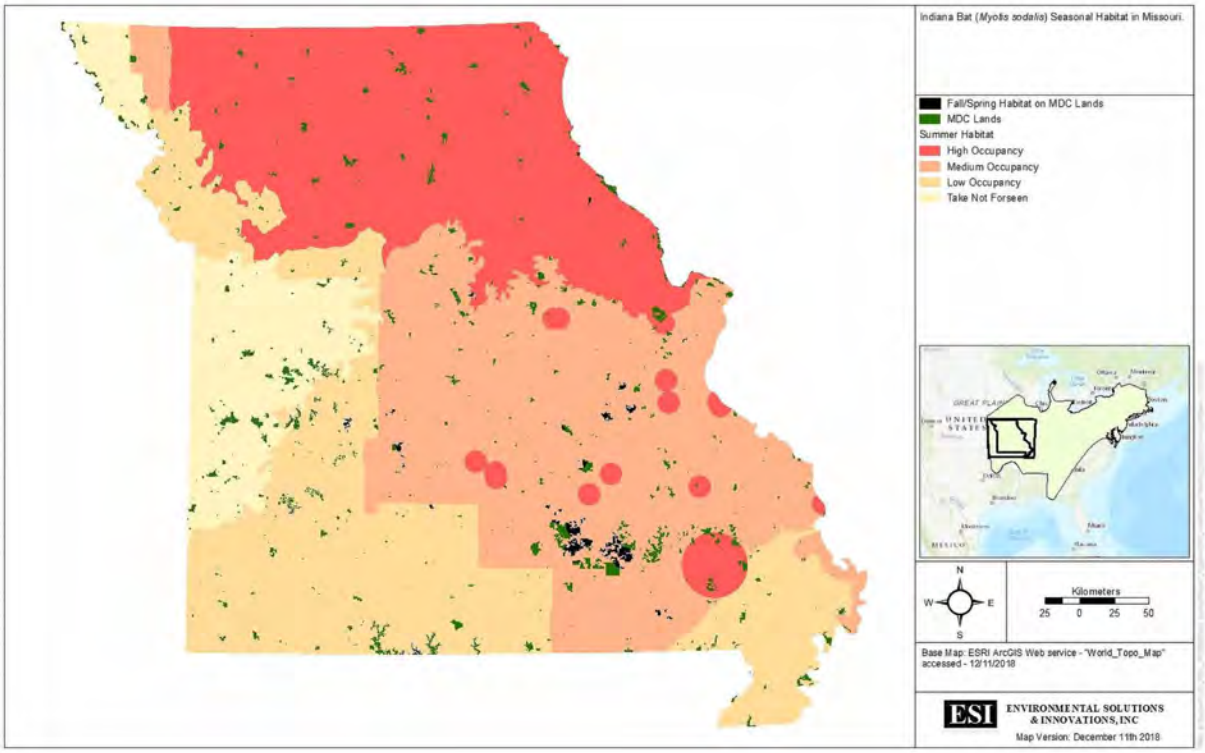


Figure 2. *Indiana bat (Myotis sodalis) seasonal habitat in Missouri. Note: Data changes over time. Coordination with MDC and USFWS is recommended early in project development to ensure new records within or near the proposed project are identified.*

Figure 3. *Feathered and unfeathered turbine blades. (reddit.com)*

Additional guidance could come from the Missouri Comprehensive Conservation Strategy (2020). This document identifies conservation priority geographies outlined with respect to the conservation strategy of key conservation organizations in the state and protection of threatened and endangered flora, fauna, and ecosystems. Included in the plan are the priority conservation areas that encompass land owned and managed by USFWS, MDC, The Nature Conservancy, the L-A-D Foundation, Missouri Prairie Foundation, and Missouri State Parks (MoDNR).

In September 2015, 17 members of the American Wind Energy Association (now the American Clean Power Association) announced they would begin to slow down turbines during low-wind conditions and peak bat migration. This period is from mid-July to mid-October. The technique, called feathering, turns the blades parallel to the wind (changing the pitch angle of the blade) and slows the blade rotations to 1–3 turns per minute (see *Figure 3*). Early studies show this may reduce bat mortality by up to 30%.

All wind energy development in the state of Missouri should plan for a minimum 2.5-mile buffer around priority conservation landscapes containing critical habitat. Priority conservation areas with wetlands and lakes within their boundaries should consider a greater than 2.5-mile buffer. In some instances, a larger buffer may be needed after consultation with USFWS, MDC, and other conservation stakeholders. Given the prevalence of federally listed bat species within Missouri, forested and riparian habitats should be considered known areas of wildlife congregation under **USFWS Land-**

Based Wind Energy Guidelines Tier 1 Questions (see link on *Page 6*) and should follow all guidance for surveying and wildlife assessment (**USFWS: Indiana Bat Survey Guidelines**).

All wind energy development in the state of Missouri should plan for a minimum 2.5-mile buffer around priority conservation landscapes containing critical habitat.

Additional measures can be identified to protect wildlife, including curtailing generation during bird and bat migration/movement and conditions with low visibility. Curtailment includes raising the wind speed at which turbines begin to operate. In high-risk areas, curtailment could include ceasing operations during specified seasons and times of enhanced risk (such as summer maternity season or fall migration for bats). Portable radar units are among the technologies that can assist in real time "smart curtailment" and can be used in areas with bird and bat migration/movement, greatly decreasing collisions. Measures to be implemented during migration and low-visibility conditions, such as curtailment or locking blades, should be clearly outlined in the project plan presented to USFWS, MDC, Missouri Department of Natural Resources (MoDNR) and other conservation stakeholders.

Post-construction fatality monitoring for bats should follow an Evidence of Absence (EoA) approach for a minimum of three years.

Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines:
https://www.fws.gov/library/collections/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines

Table 1: Summary of publicly available curtailment studies on bats in USFWS Region 3 (includes Missouri)

Project	Year	Region 3 State	Cut-In Speed (m/s)	Fatality Reduction	North America Average Fatality Reduction [1–14]	Citation
Fowler Ridge	2011	Indiana	3.5	36%	36%	Good et al. 2012
Fowler Ridge	2011	Indiana	4.5	57%	59%	Good et al. 2012
Fowler Ridge	2010	Indiana	5	50%	55%	Good et al. 2011
Fowler Ridge	2011	Indiana	5.5	73%	66%	Good et al. 2012
Anonymous 1	2010	USFWS Region 3	–	72%	–	Arnett et al. 2013
Sheffield, Anonymous 2	2012	n/a	6	–	51%	–
Fowler Ridge	2010	Indiana	6.5	78%	76%	Good et al. 2011
Beech Ridge	2012	n/a	6.9	–	81%	Tidhar et al. 2013

1. Arnett, E.B., M.M.P. Huso, M.R. Schirmacher, and J.P. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. *Frontiers in Ecology and the Environment*. 9(4): 209-214.

2. Arnett, E.B., G.D. Johnson, W.P. Erickson, and C.D. Hein. 2013. *A Synthesis of Operational Mitigation Studies to Reduce Bat Fatalities at Wind Energy Facilities in North America*. A report submitted to The National Renewable Energy Laboratory. Prepared by Theodore Roosevelt Conservation Partnership, Western EcoSystems Technology, Inc., and Bat Conservation International. March 2013.

3. Baerwald, E.F., J. Edworthy, M. Holder, and R.M.R. Barclay. 2009. A Large-Scale Mitigation Experiment to Reduce Bat Fatalities at Wind Energy Facilities. *Journal of Wildlife Management*. 73(7):1077-1081.

4. Good, R.E., W. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 2011. *Bat Monitoring Studies at Fowler Ridge Wind Energy Facility, Benton County, Indiana, April 13 – October 15, 2010*. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. January 28, 2011.

5. Good, R.E., A. Merrill, S. Simon, K. Murray and K. Bay. 2012. *Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana, April 1 – October 31, 2011*. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. January 31, 2012.

6. Good, R.E., G. Iskali, and K. Nasman. 2016. *Bat Evaluation Monitoring Studies at Fowler Ridge Wind Farm, Benton County, Indiana: August 3 – October 14, 2015*. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. January 28, 2016.

7. Hein, C.D., A. Prichard, T. Mabee, and M.R. Schirmacher. 2013. *Effectiveness of an Operational Mitigation Experiment to Reduce Bat Fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2012*. An annual report submitted to Edison Mission Energy and the Bats and Wind Energy Wind Cooperative. Bat Conservation International, Austin, Texas.

6. Hein, C.D., A. Prichard, T. Mabee, and M.R. Shirmacher. 2014. *Efficacy of an operational minimization experiment to reduce bat fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2013*. An annual report submitted to Edison Mission Energy and the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

7. Martin, C., E. Arnett, and M. Wallace. 2013. *Evaluating Bird and Bat Post-Construction Impacts at the Sheffield Wind Facility, Vermont, 2012*. Annual report prepared for Bat Conservation International and First Wind. March 25, 2013

8. Stantec Consulting Ltd. 2012. *Wolfe Island Wind Plant, Post-Construction Follow-up Plan, Bird and Bat Resources, Monitoring Report No. 6, July – December 2011*. Prepared for TransAleta Corporation's wholly owned subsidiary, Canadian Renewable Energy Corporation. July 2012.

9. Stantec Consulting Services Inc (Stantec). 2015. *2014 Bird and Bat Post-Construction Monitoring Report – Laurel Mountain Wind Energy Project, Randolph and Barbour Counties, West Virginia*. Prepared for AES Laurel Mountain Wind, LLC. January 2015.

10. Tidhar, D., M. Sonnenberg, and D. Young. 2013. *2012 Post-Construction Carcass Monitoring Study for the Beech Ridge Wind Farm, Greenbrier County, West Virginia – Final Report, April 1- October 28, 2012*. Prepared for Beech Ridge Wind Farm, Beech Ridge Energy, LLC. January 18, 2013.

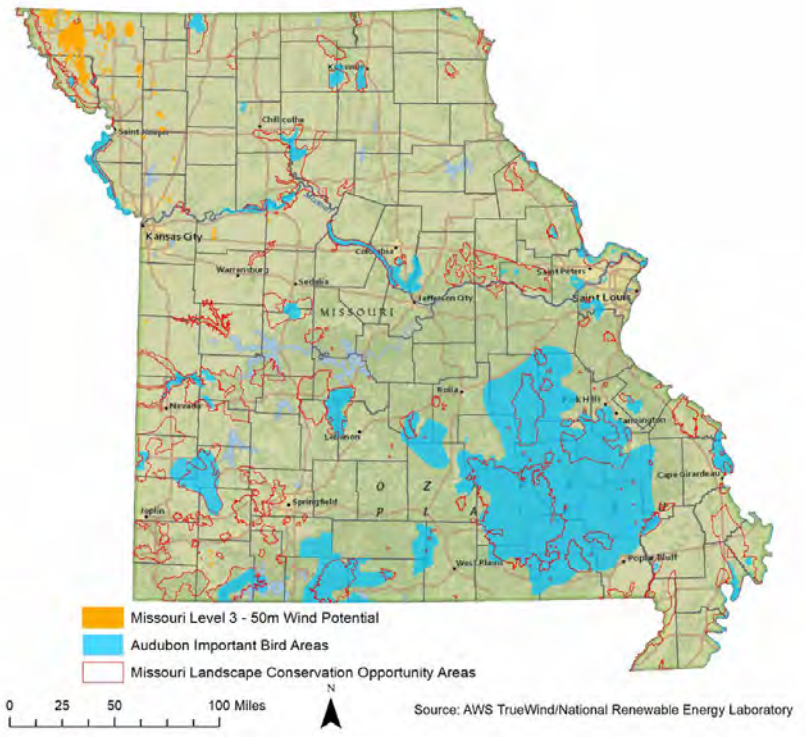
11. Young, D.P., W.P. Erickson, K. Bay, S. Nomani., and W. Tidbar. 2009. *Mount Storm Wind Energy Facility, Phase 1 Post-Construction Avian and Bat Monitoring, July-October 2008*. Prepared for NedPower Mount Storm, LLC. Prepared by Western EcoSystem Technology, Inc.

12. Young, D., and J. Gruver. 2011. *Bat Mist Netting and Acoustic Surveys Beech Ridge Wind Energy Project GreenBrier and Nicholas Counties, West Virginia*. Prepared for Beech Ridge Energy LLC. Prepared by Western EcoSystems Technology, Inc. Revised June 27, 2011.

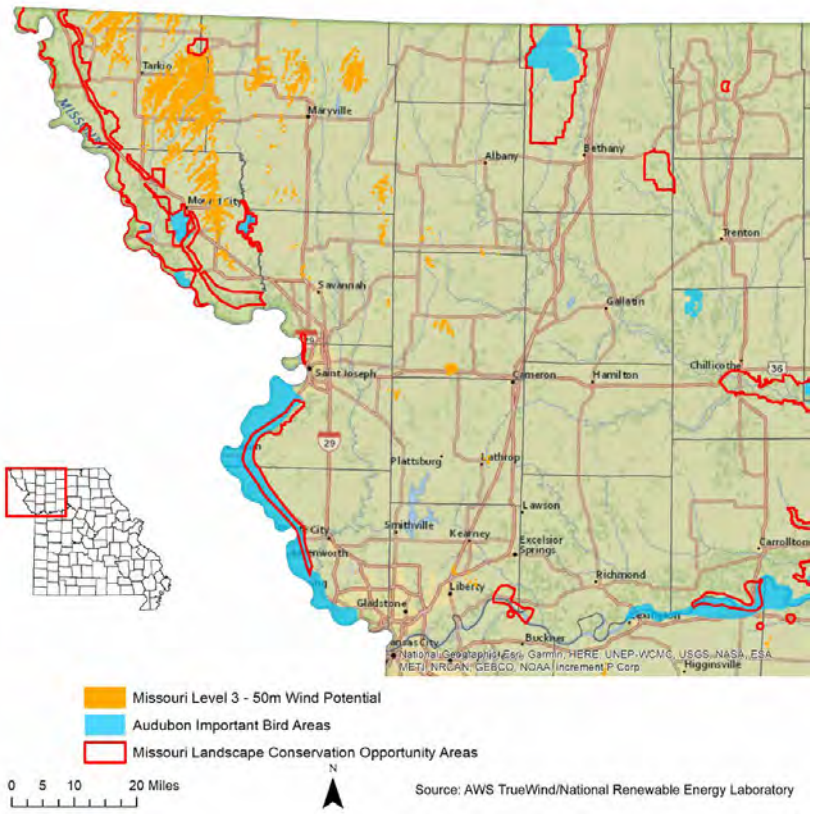
13. Young, D.P., S. Nomani, Z. Courage, and K. Bay. 2012. *NedPower Mount Storm Wind Energy Facility PostConstruction Avian and Bat Monitoring, July-October 2011*. Prepared for NedPower Mount Storm, LLC. Prepared by Western EcoSystems Technology, Inc. February 27, 2012.

14. Young, D., C. Nations, M. Lout, and K. Bay. 2013. *2012 Post-Construction Monitoring Study, Criterion Wind Project, Garret County, Maryland, April – November 2012*. Prepared for Criterion Power Partners, LLC. Prepared by Western EcoSystems Technology, Inc. January 15, 2013.

Maps 1 & 1a: Wind Potential, Conservation Opportunity, and Important Bird Areas



Map 1. *Missouri Landscape Conservation Opportunity Areas and Important Bird Areas overlaid with the top areas for wind energy development based on wind potential.*



Map 1a. *Detail of northwestern Missouri with wind map overlay.*

Areas used by wildlife or people—such as Missouri State Parks, Missouri State Recreation Areas, National Wildlife Refuges, MDC Conservation Areas, and designated Missouri Natural Areas—should be avoided, both for the benefit of wildlife and to preserve Missouri's priority conservation landscapes, as well as native biodiversity. A minimum 2.5-mile buffer from any boundary of these areas should be applied.

Missouri has unique geological features such as the loess hills of northwestern Missouri and the Ozark mountains. Ideally, wind farms should not be located in the vicinity of these regions for biological and aesthetic reasons; at a minimum, maintain a 2.5-mile buffer from any Ozark mountain, loess hill, or other significant geologic feature. Additionally, avoid any alterations of landscape such as flattening mountaintops or creating steep slopes that would accelerate erosion.

3a. Pre-Siting Evaluation Studies

» Consultation with the USFWS, MDC, and other appropriate stakeholders should begin early during site screening and assessment for data identifying best areas for development and avoiding negative impacts to Missouri's priority conservation landscapes. Conservation and wildlife agencies and affected public stakeholders should have a forum in which to comment during the development phase.

» Studies to assess the site's impact on Missouri's priority conservation landscapes should be conducted early in the planning process. Surveys should include plant communities, bird counts, nest searches, radar, and acoustic and visual monitoring for nocturnal migratory birds, resident bats, and migratory bats. Special care should be given to identify presence and prevalence of species of special concern over at least two complete years.

» Information contained in pre-siting evaluation studies should include:

- Appropriate study design and sample size
- Site-specific wildlife studies, as wildlife use and species occurrence can vary considerably
- Recently collected and relevant data using current methodology to determine the conservation significance of a given site, including bat data collected during migratory and residency periods, as well as data from overnight, dusk, and dawn hours; for example, the active season for bats in Missouri is March 15–November 1
- Acoustic surveys that contain data from the summer maternity season and migratory periods of spring and fall, effectively documenting presence/absence (Note: follow the current Indiana bat survey guidelines for spring, summer, and fall)

Missouri has unique geological features such as the loess hills of northwestern Missouri and the Ozark mountains. Ideally, wind farms should not be located in the vicinity of these regions for biological and aesthetic reasons.

- Mist-net surveys during the summer maternity season to document on-site habitat use when presence has been established by acoustic surveys
- Information on any frequent weather conditions, such as dense fog or low cover, that might increase bird-collision risk

3b. Best Practices for Siting in Least Conflict Areas

» Wind power development should avoid:

- placement in northeast Missouri (refer to Indiana bat seasonal habitat in Missouri, *Figure 2*);
- siting near transmission lines that previously discovered federally protected species during environmental studies.

» Priority conservation landscapes, other natural areas, public-use areas, wildlife-migration corridors (including proximity to the largest known hibernacula in the Indiana bat's range, Hannibal, MO), and migration staging areas should be avoided or given adequate buffers—at a minimum, a 2.5-mile buffer (10 miles in the case of bat caves) or a buffer distance based on most current scientific findings.

» The impact of cumulative wind energy projects should be considered in any development plan (habitat conservation plan, environmental assessment, etc.)

3c. Practices for Minimizing Impact to Wildlife and Natural Environment

» Towers and poles, particularly in grasslands, should be designed to exclude perches for avian predators (such as external ladders or platforms). Utilize tubular monopoles instead of lattice designs or other possible perches. Guy wires should be avoided.

Advisory Circular from the U.S. Department of Transportation:
https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_.pdf

» Turbine warning lights should be designed and placed to avoid any adverse effect on migrating birds and bats, including a plan to address low-ceiling and fog conditions.

Towers and poles, particularly in grasslands, should be designed to exclude perches for avian predators.

» Use of red steady lights should be avoided. Pulsating red lights are estimated to reduce bird collisions by 50-70% (Audubon 2016). Consult the **Advisory Circular from the U.S. Department of Transportation** that sets forth standards for marking and lighting obstructions that have been deemed to be a hazard to navigable airspace.

» To the extent possible, transmission and power lines should be buried (via boring, not trenching) and be able to withstand burning of native vegetation on the surface above.

» If burying lines is not possible, optimal use should be made of any existing transmission line corridors. Additionally, any above-ground lines should be shielded, insulated, and marked with bird-flight diverters. All efforts should be made to avoid avian electrocution or providing perches.

» Minimize roads and fences. Avoidance behavior by ground birds should be considered.

» Re-establishment of vegetation on construction sites should consist of native vegetation, preferably with native plant seeds of local genotypes. Re-vegetation with a monoculture should be avoided.

» All efforts to avoid introducing non-native species should be taken, and a plan developed for controlling non-native, invasive plants post re-vegetation, including a plan for adherence post re-vegetation.

3d. Monitoring and Best Post-Construction Practices

» A minimum of 2 years pre-construction and 3 years post-construction monitoring to determine bird, bat, and other wildlife numbers, mortality, and migration use. The National Wind Study Coordinating Collaborative Guidelines should be followed.

» All carrion, including livestock and wildlife, should be removed from the area of the wind farm to avoid attracting avian species such as vultures, eagles, and hawks.

» All turbines should feather blades when they are not producing electricity. Feathering blades (turning them parallel to the wind, see *Figure 3*) has been found to effectively reduce bat fatalities (Baerwald et al. 2009).

» Environmental assessments should be conducted for each project by a qualified consultant specializing in bird and bat ecology.

These wind energy infrastructure conservation siting guidelines are adapted from guidelines developed by Burroughs Audubon Society of Greater Kansas City.

II. GUIDELINES FOR SOLAR ENERGY INFRASTRUCTURE CONSERVATION SITING[1]

The purpose of the following guidelines is to inform and guide solar energy infrastructure developers, operators, community planners, and other stakeholders to voluntarily site, construct, and operate the infrastructure in ways that minimize impacts to Missouri's priority conservation landscapes.

The first rule for siting solar is that it should be unnecessary to encroach on intact habitat and other biologically sensitive areas. Solar photovoltaic (PV) panel siting priority should be rooftops and carports, or as canopy over parking lots and similar hardscape expanses. On farms, "dual use" solar PV not only provides electricity, but also can accommodate pollinator-friendly plants and shelter shade-tolerant crops. There is ample room to meet our energy needs in these spaces.

On disturbed or degraded land, solar PV panels can coexist with wildlife and even enhance this land with pollinator-friendly plantings, native vegetation buffers, and wildlife corridors. Utility-scale solar arrays that can cover many acres of degraded land should be planned with the establishment of native vegetation in mind.

The first rule for siting solar is that it should be unnecessary to encroach on intact habitat and other biologically sensitive areas.

Summary

1. **Avoid intact areas of high native biodiversity.** Avoid siting in Missouri priority conservation geographies, and intact natural communities including original prairie, sand prairie, and other open, native grasslands and savanna areas.

2. **Allow for wildlife connectivity, now and in the face of climate change.** Avoid siting in and fragmenting current or future wildlife corridors that may disrupt habitat connectivity. Where appropriate, use wildlife-friendly fencing or unfenced wildlife passageways around solar energy infrastructure. Allow for ample wildlife corridors between fencing and roads.

1. North Carolina TNC: http://conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/Documents/ED_TNCNCPrinciplesofSolarSitingandDesignJan2019.pdf served as a framework for these solar energy infrastructure conservation siting guidelines.

3. **Siting priority should be on top of buildings, in parking lots, or, if on land, disturbed or degraded lands rather than intact habitat.** Retain or plant appropriate native vegetation/ trees in buffers or outside of perimeter fences.

4. **Protect water quality and avoid erosion.** Do not site in floodplains. Buffer streams and wetlands with native plants (and trees, if applicable) within or outside perimeter fences.

Details on each of the above-listed principles:

1. Avoid Missouri's priority conservation landscapes and remnant native habitats. If any solar arrays are planned for these areas, they should not be ground-mounted, but instead placed on rooftops or as canopies. Avoiding siting in these areas is the simplest yet most important conservation step in siting solar (see Map 2). These Conservation Opportunity Areas are likely to have the highest levels of species biodiversity now and in the future.

Given the extreme rarity of original, unplowed prairie, special emphasis should be taken to avoid siting solar development on original, unplowed prairie. Less than ½ of 1% of original prairie remains in Missouri and keeping original prairie remnants intact is a high statewide conservation priority.

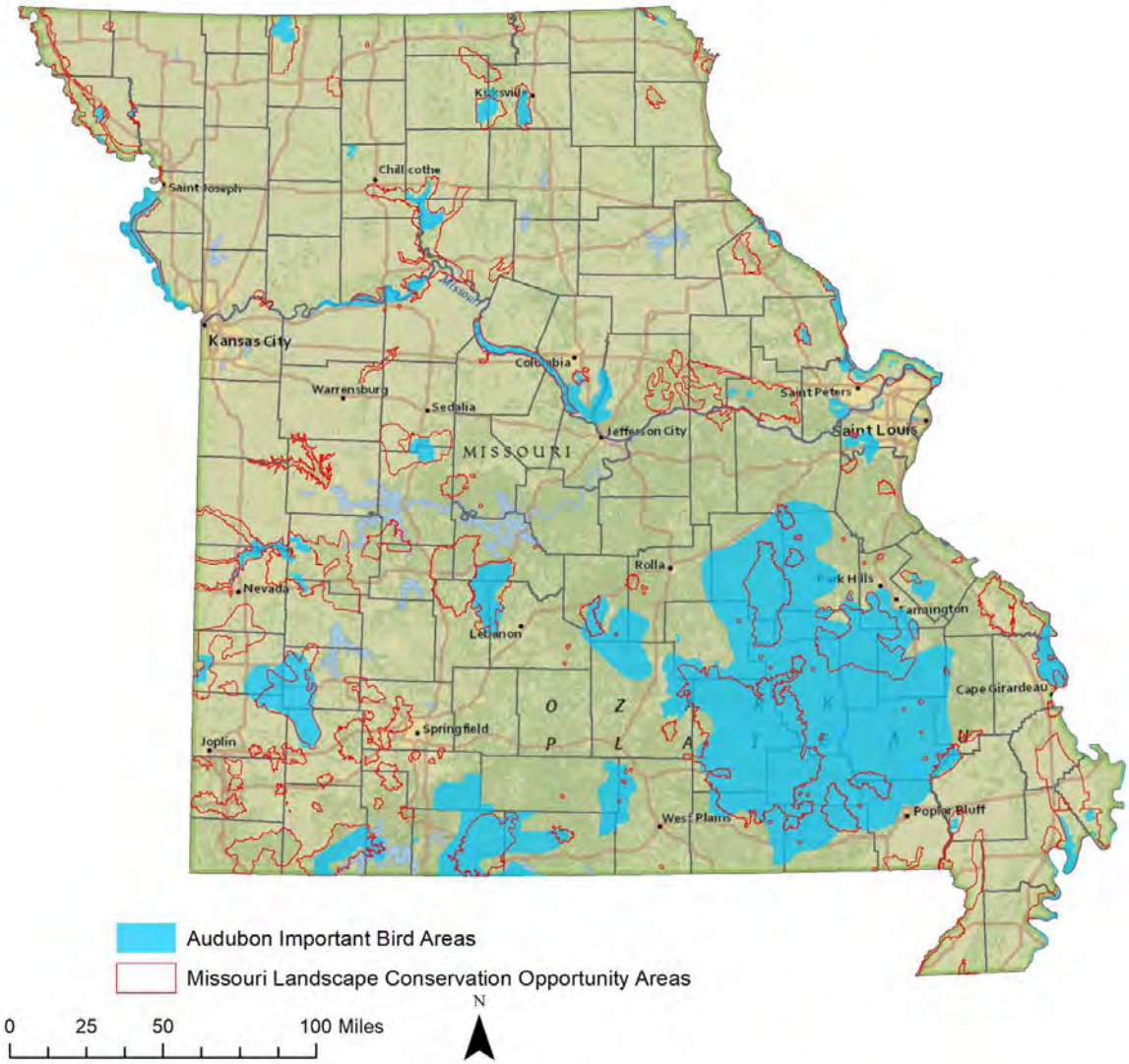
> **Special emphasis should be taken to avoid siting solar development on original, unplowed prairie.**

Protect and restore on-site wildlife habitat features (e.g., wetlands, vegetated buffers). If there are special habitat features in or near the proposed solar facility that cannot be avoided via the siting process, the developer should incorporate them into site design. Florida Power and Light, for example, has designated facilities that provide habitat as "solar sanctuaries" and include vegetated areas and buffers, intact (or restored) wetlands, and patches of forest. This existing habitat is likely in use by native wildlife prior to development.

Provide supplemental wildlife habitat as appropriate: Create or restore vegetation on the site and focus on native plant species and communities that provide wildlife cover, food (e.g., fruit, mast, pollen), and breeding habitat. As practical, the solar site should be designed with open areas spread throughout and planted and maintained with taller plant species. This practice would benefit pollinators, create diversity across the site, and provide needed shelter islands to aid in the movement of small-to-medium-sized animals. Supplemental habitat features can also be added to a site to encourage native wildlife to use and live near or on the site.

Determining the best features to include depends on the species of native wildlife in the region that might benefit from additional nesting or foraging structures. For example, replacing cleared trees may be appropriate. However, in a grassland area, perches (including trees) will be utilized by raptors and can create a sink for prey species, such as grassland birds. While these practices have not been tested on solar facilities, they are successful in a variety of other suburban and urban settings; they include downed wood, bat boxes, bird nesting boxes, and sand piles (for native bees).

2. Allow for wildlife connectivity, in the present and in the face of climate change. Avoid siting in and fragmenting current or future corridors for habitat connectivity. Little is known about the potential impact of solar facilities on wildlife movement, which can



Map 2. *Important Bird Areas and Conservation Opportunity Areas.*
For more information on Missouri IBAs: http://mo.audubon.org/important-bird-areas-5

vary greatly from site to site and with type of wildlife. For example, bird and bat movements are likely minimally impacted by solar development (but abundance and diversity of insects, which birds and bats eat, may be impacted), whereas ground-based wildlife may experience more impact to daily or seasonal movement. Further, as plant species and wildlife shift their ranges because of climate change, barriers to such shifts could occur, and any development, including solar, could impede these shifts. Where appropriate, use wildlife-friendly fencing or unfenced wildlife corridors. Wildlife connectivity and movement may be of greatest concern where there is adjacent habitat disrupted by the presence of the solar facility. Solar facilities generally use fencing that may act as a barrier to larger, ground-based wildlife movement. While best-management practices for wildlife-friendly fencing are still under research, fencing that allows small- to medium-sized animals (e.g., turtles, raccoons, birds) to pass through or providing wildlife passages (8-inch diameter HDPE pipe) roughly 500 feet apart around a site is recommended. Equally important is providing on-site vegetation that provides cover for animals when moving through a site.

The best method for allowing movement of both large and small animals, and particularly appropriate in large solar installations (i.e., >50 acres), is to retain unfenced wildlife passageways through the solar facility. Solar developers typically avoid development near rivers, streams, and their associated riparian areas and wetlands, and these areas can then serve as wildlife passageways.

3. Preferentially use tops of buildings, hardscape, or previously developed lands. Preferentially siting and installing solar infrastructure on existing structures (e.g., rooftops) avoids impacts to wildlife habitat. If siting and installation must occur on land, site solar facility development on previously degraded or developed lands (e.g., brownfields or sites with prior development). Clearing intact woodlands, forest, or prairies or other native grasslands should be avoided. It should also be noted that some sites that were previously developed and then abandoned may contain new vegetation (i.e., early successional habitat) or other features that can be beneficial to some wildlife species. Thus, defining "degraded" requires a site-level evaluation of intact soil, native or non-native vegetation, and wildlife habitat. Using degraded sites may reduce the amount of biologically sequestered carbon lost due to solar project construction. Clearing land of native vegetation disturbs sequestered carbon, thus reducing the benefits of clean energy production in the short term. While ultimately an acre of PV solar may result in fewer carbon emissions than the equivalent amount of wooded land or prairie can sequester, the optimal scenario is when a wooded area or prairie is left intact to continue its role in carbon sequestration, and solar development is sited elsewhere. Also, if intact habitat is cleared and graded for solar development, that destruction would result in not only loss of carbon from the soil organic layer but also decreased microbial biomass and activity, and additional loss of soil through erosion and runoff. If siting on land, developers should preferentially site solar facilities on cleared land that is least suitable for agriculture.

> **Clearing intact woodlands, forest, or prairies or other native grasslands should be avoided.**

If siting on disturbed land, solar facilities represent an opportunity to restore native vegetation. The Grow Native! program provides comprehensive information on native planting, including a directory of native plant, tree, and seed suppliers. When compared to turfgrass, the use of native vegetation increases biodiversity at a given site, requires less mowing and herbicide use, minimizes erosion issues, more effectively attenuates the flow of stormwater, and increases soil health and carbon sequestration. If restoration with native plants is not feasible, then non-native, non-invasive, pollinator-friendly plants (e.g., white clover) may be an acceptable alternative, as long as these plants do not impact nearby native habitat. Pollination is a key service that this practice provides, and thus its implementation may be most relevant for solar facilities located within an agricultural matrix.

4. Protect water quality and avoid erosion. Do not site in floodplains. Not locating solar facilities in these areas is both protective of floodplain ecological function and also guards solar facilities from flooding, especially during extreme weather events, ensuring the resilience and reliability of our energy supply into the future. Generally, avoiding steeply sloped sites that require extensive grading will reduce potential for erosion, sedimentation, and runoff, and thus reduce impacts to water quality. Buffer streams and wetlands from solar facilities.

III. GUIDELINES FOR PIPELINE AND TRANSMISSION LINE CONSERVATION SITING

The purpose of the following guidelines is to inform and guide pipeline developers, transmission providers, regional transmission organizations, operators, community planners, and other stakeholders to voluntarily site, construct, and operate linear infrastructure to both efficiently provide power and minimize impacts to natural ecosystems and biodiversity.

Pipelines run above or below ground. Transmission lines are strung atop tall poles or towers. They are functionally similar in requiring linear rights-of-way (ROWs). Their effects on wildlife arise from three processes:

1. Before construction, the right-of-way must be cleared of trees and other large vegetation. (Note that tree clearing needs to occur from November 1 – March 31 to avoid impacts to Indiana and northern long-eared bats. If clearing needs to occur outside this time, further coordination with USFWS is needed.)

2. Digging trenches for pipelines or planting the poles for transmission results in land disturbance, including soil compaction, erosion and mixing, and possibly damage to wetlands.

3. After construction, ROWs must be kept clear of vegetation that could interfere with transmission lines or sink roots that could damage pipelines. Use of chemicals may harm native biodiversity. Maintenance activities and pipeline spills can disturb wildlife and destroy habitat.

Consultation with the USFWS, MDC, MoDNR, and other appropriate stakeholders should begin early in the route planning process. Because transmission lines are inextricably linked to new sources of generation, including renewables, preliminary siting steps should include review of the Nature Conservancy's **Site Renewables Right tool** (find link on *Page 4*) for Missouri. Follow-up with USFWS and MDC about protected and sensitive species in specific target development areas can help to identify and avoid areas with known conflicts. For example, MDC has information about species occurrences and areas of enhanced risk (see *Figure 3* regarding Indiana bat).

Additional guidance should come from the **Missouri Comprehensive Conservation Strategy** (2020).

Missouri Comprehensive Conservation Strategy:
https://tinyurl.com/2ouwzzme

It is possible to bury pipelines and transmission lines (boring creates less disturbance than trenching). Undergrounding is usually confined to urban areas because it often costs several times as much as above-ground lines and results in much more land disturbance than spaced poles. The heat from the cables can permanently dry out the soil and restrict agricultural practices. Undergrounding is unlikely to become prevalent in rural areas.

Pipelines and transmission lines should take maximum advantage of existing utility rights-of-way. They should minimize crossings of conservation lands, waters, and wetland complexes. Clearing woodlands or forest habitat, or damaging intact native grasslands, for rights-of-way creates edge habitat used by some species, but diminishes habitat for species that require unbroken tracts of wooded or native grassland habitat.

Information contained in pre-siting evaluation studies for transmission lines should include:

- Appropriate study design and sample size
- Site-specific wildlife studies, as wildlife use and species occurrence can vary considerably
- Information on any frequent weather conditions such as dense fog or low cover that might increase collision risk

During construction, care should be taken to minimize soil compaction, erosion, and other land disturbance. To the extent possible, access roads should be removed and the land returned as close as possible to its original condition. Revegetation can be done in a way that converts the rights-of-way to wildlife- and pollinator-friendly habitat, avoiding the need to clear overgrown brush in the future. Native wildflowers and grasses provide food and shelter for deer, turkeys, rabbits, butterflies, and songbirds.

Birds are at risk from collisions with power lines. To minimize avian risk, the builder should develop an Avian Protection Plan in accordance with the suggested guidance and best practices identified by the Avian Power Line Interaction Committee.

Photo: Mary Nemecek

REFERENCES

Air Pollution, a Warming Climate, and the Troubled Future for America's Hunting and Fishing Heritage: https://www.nwf.org/~/media/PDFs/Global-Warming/Reports/NWF_GameChangers_FINAL.ashx

American Clean Power Association (ACP). https://cleanpower.org/

Bateman, B. L., C. Wilsey, L. Taylor, J. Wu, G. S. LeBaron, and G. Langham. North American birds require mitigation and adaptation to reduce vulnerability to climate change. *Conservation Science and Practice*. 2020; 2:e242. https://doi.org/10.1111/csp2.242

Bateman, B. L., L. Taylor, C. Wilsey, J. Wu, G. S. LeBaron, and G. Langham. Risk to North American birds from climate change-related threats. *Conservation Science and Practice*. 2020; 2:e243. https://doi.org/10.1111/csp2.243

Baerwald, E., J. Edworthy, M. Holder, and R. M. R. Barclay. 2010. A large-scale mitigation experiment to reduce bat fatalities at wind energy facilities. *The Journal of Wildlife Management*. 73. 1077 - 1081. https://doi.org/10.2193/2008-233

Hayes, M. A. 2013. Bats killed in large numbers at United States wind energy facilities. *BioScience*. 63:975–979.

Midwest Short-term Habitat Conservation Plans (HCP): https://fws.gov/service/habitat-conservation-plans. Additional information on HCPs can be found here: https://fws.gov/library/collections/habitat-conservation-plans

Missouri Comprehensive Conservation Strategy (2020). Available upon request from the Missouri Department of Conservation: https://mdc.mo.gov

Missouri Natural Heritage Review website: https://naturalheritagereview.mdc.mo.gov/

National Wind Study Coordinating Committee Guidelines: https://tethys.pnnl.gov/organization/national-wind-coordinating-collaborative

Pruitt, L. and Reed, M. 2022. Indiana Bat Fatalities at Wind Energy Facilities. U.S. Fish and Wildlife Service. Available at: https://www.fws.gov/sites/default/files/documents/Indiana%20Bat%20Fatalities%20at%20Wind%20Energy%20Facilities.pdf

REWI (formerly AWWI). 2018. A Summary of Bat Fatality Data in a Nationwide Database. Washington, DC. Available at: https://rewi.org/wp-content/uploads/2019/02/AWWI-Bat-Technical-Report_07_25_18_FINAL.pdf

Smallwood, K. S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. *Wildlife Society Bulletin.* 37:19–33.

The Nature Conservancy's Site Wind Right tool: https://www.nature.org/en-us/what-we-do/our-priorities/tackle-climate-change/climate-change-stories/site-wind-right/

U.S. Department of Transportation advisory circular that sets forth standards for marking and lighting obstructions that have been deemed to be a hazard to navigable airspace: http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_.pdf

U.S. Energy Administration. Missouri State Profile & Energy Estimates: https://www.eia.gov/state/analysis.php?sid=MO

U.S. Fish and Wildlife Service. Indiana Bat Survey Guidance: https://www.fws.gov/midwest/endangered/mammals/inba/inbasummersurveyguidance.html

U.S. Fish and Wildlife Service. Land-Based Wind Energy Guidelines: https://www.fws.gov/ecological-services/es-library/pdfs/weg_final.pdf

WHAT WE HAVE LEFT... AND WHY IT MATTERS

Photo: Mary Nemecek

Photo: Bruce Schuette

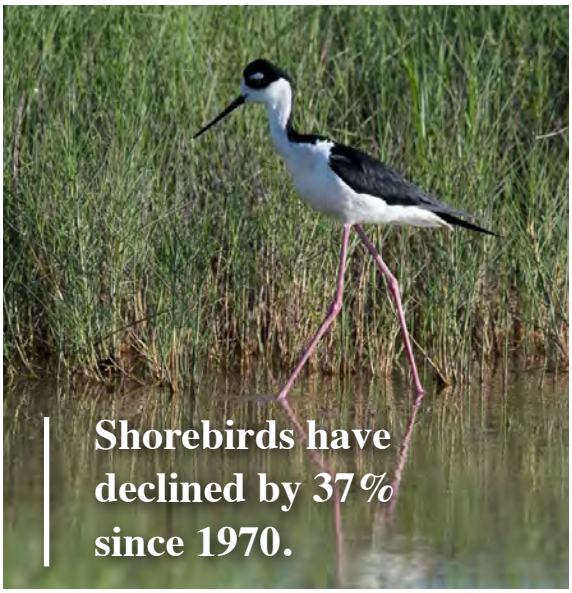


Photo: Karen Davis

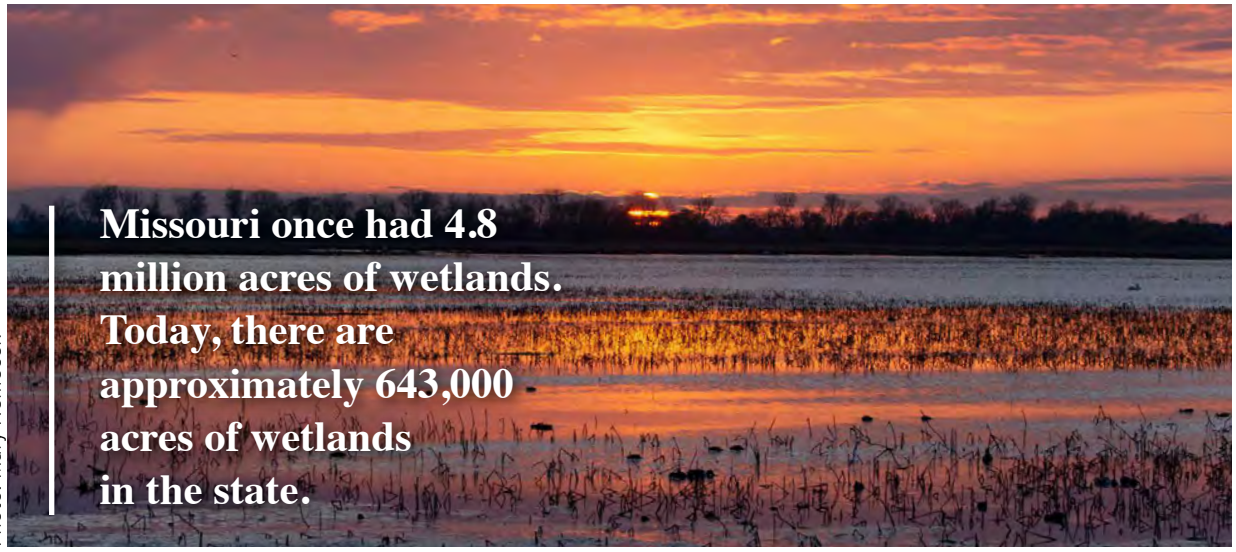


Photo: Mary Nemecek

SUPPORTING ORGANIZATIONS

Burroughs Audubon Society of Greater Kansas City

Missouri Prairie Foundation — Protecting Native Grasslands — www.moprairie.org

Great Rivers Environmental Law Center — Lawyers for the Environment

CFM Conservation Federation Missouri

Bat Conservation International

Ducks Unlimited

The Nature Conservancy

Sierra Club

Missouri Parks Association

L-A-D Foundation — Since 1962

Platte Land Trust — Together protecting the land we love.

Missouri Native Plant Society

MonarchWatch.org — Education · Conservation · Research

Missouri River Bird Observatory

Missouri Birding Society — Missouri's Ornithological Society Since 1901

Greater Ozarks Audubon

Powell Gardens — Kansas City's Botanical Garden

Shaw Nature Reserve

Columbia Audubon Society

Bridging The Gap

St. Louis Audubon Society

Springfield Plateau Chapter — Missouri Master Naturalist — a partnership of the Missouri Department of Conservation and the University of Missouri Extension

Midland Empire Audubon Society