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Wind Energy and Wildlife Research at the Forest and Rangeland Ecosystem Science Center

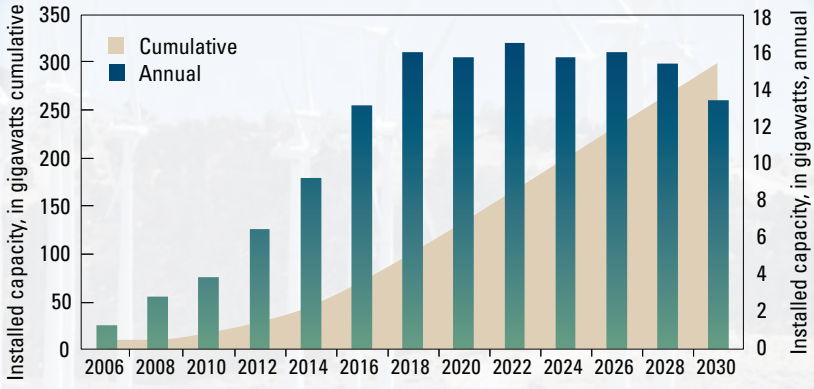
Overview

The United States has embarked on a goal to increase electricity generation from clean, renewable sources. Towards this end, wind energy is emerging as a widely distributed form of renewable energy throughout the country. One scenario is for energy from wind to supply 20 percent of the country's electricity by 2030 (graph).

As with many land uses, trade-offs exist between costs and benefits. New wind developments are occurring rapidly in parts of the United States, often leaving little time for evaluation of potential site-specific effects. These developments are known to affect wildlife, directly from fatality due to collision with the infrastructure and indirectly from loss of habitat and migration routes. The Department of the Interior, in particular, is challenged to balance energy development on public lands and also to conserve fish and wildlife. The Secretary of the Interior has proposed a number of initiatives to encourage responsible development of renewable energy. These initiatives are especially important in the western United States where large amounts of land are being developed or evaluated for wind farms.

The U.S. Geological Survey (USGS) Forest and Rangeland Ecosystem Science Center (FRESC) is assisting public agencies and private industries by providing science and technical support for use in decision making. The science capabilities of FRESC include four broad categories:

- ***Wildlife Mortality and Injury***
- ***Habitat Modification and Loss***
- ***Mitigation Options***
- ***Monitoring and Analysis***



Projected annual and cumulative wind installations by 2030 are expected to achieve the 20 percent wind goal. From http://eere.energy.gov/wind/pdfs/41869.pdf, accessed July 16, 2012.

Tehachapi Wind Turbines

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Wildlife Mortality and Injury

Modern land-based wind turbine blades can reach more than 425 feet (130 meters) above ground level. Rotor-swept areas (the area of the circle covered by a turbine blade) now exceed 1 acre (0.4 hectare) and soon are expected to reach nearly 1.5 acres (0.6 hectare). Collisions with the blades can cause death or injury to birds and bats. Bats can also suffer tissue-damaging rapid pressure changes during flight near turbines. The immediate effects to species may be only near the turbines, but greater effects can accumulate in various ways. For example, local breeding populations could be diminished by injury or fatalities on their winter ranges. Mortality could also be compounded as members of a population encounter multiple wind facilities along a migratory route.

Bats

FRESC is developing statistically robust tools to estimate fatality of bats from carcasses found at wind facilities. Simple counts do not reflect actual fatality because carcasses are detected at different rates, often depending on season and vegetation around turbines. Simple counts must be adjusted by estimates of the likelihood of detection for each carcass. FRESC scientists are making refinements to an existing estimation tool to account for repeated carcass searches and to incorporate alternative models of detection probability. This improved estimator will be helpful in evaluating local and cumulative effects of wind developments.

Big brown bat (in flight) and hoary bat (closeup)

Bats flying at dusk

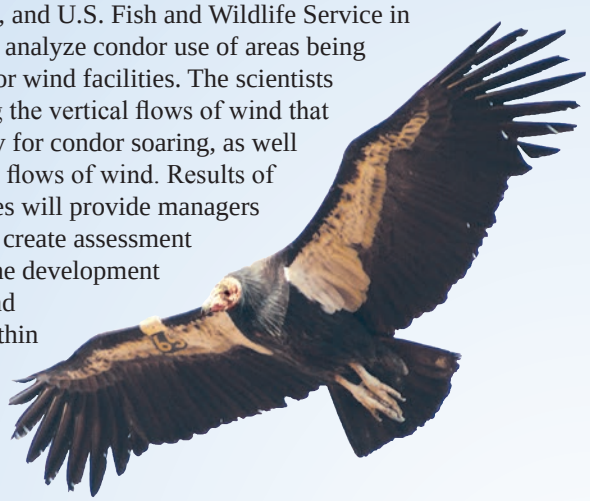
Golden Eagles

The planned and actual development of wind facilities has increased dramatically within the range of the golden eagle, and in some areas, eagle collisions with wind turbines are a source of mortality. Golden eagles are protected under the Bald and Golden Eagle Protection Act and several other statutes, such as the Migratory Bird Treaty Act. The U.S. Fish and Wildlife Service guidelines require that wind developments consider manageable risks to eagles across landscapes. Developers are required to conduct an evaluation of the risks to golden eagles associated with wind development, which includes mortality as well as adverse effects to the landscape that eagles use. FRESC is mapping locations of golden eagles and conducting scientific modeling to predict eagle occurrence based on natural features of the landscape, such as topography, geology, and anthropogenic features, including potential energy-development areas. The results will be useful in deciding where to focus eagle surveys to delineate areas of high eagle occurrence, and thus, potential for focused management. Areas of low eagle occurrence are potentially better areas for wind development.

Golden eagle approaching chick in nest

California Condors

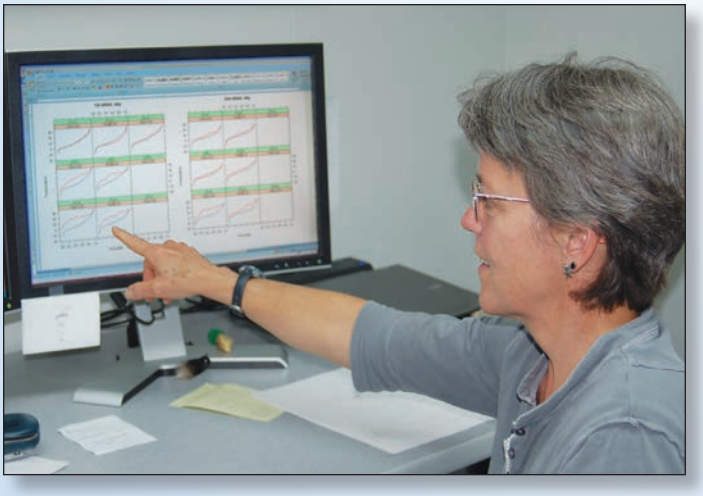
Due to the small number of endangered California condors, any negative effects from wind-energy development could jeopardize recovery of the species. Scientists at FRESC are helping the Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service in California to analyze condor use of areas being considered for wind facilities. The scientists are modeling the vertical flows of wind that are necessary for condor soaring, as well as horizontal flows of wind. Results of these analyses will provide managers with tools to create assessment criteria for the development of future wind resources within the range of California condors.



California condor

Habitat Modification and Loss

The footprint of a wind facility, where the turbines are installed, ranges from a few acres to dozens of square miles. Most of these facilities tie into existing electricity transmission infrastructure and require service roads and power lines. This infrastructure can have direct and indirect effects on habitat, such as loss or modification of foraging habitat and increased isolation between habitat patches. Habitat changes, in turn, influence the health of wildlife populations. Examples of these possible influences include reduced nesting and breeding densities, loss of population vigor and overall population densities, and behavioral changes. Various other factors can lead to indirect effects, including introduction of invasive plants, increased predator populations or facilitated predation, and alterations in the natural fire frequency. There can be time lags between the cause and the effect. Information about distribution, abundance, habitat requirements, and migratory patterns is needed for any species of interest. A surprisingly small amount of well-documented information about these characteristics is currently available for many species.



USGS scientist reviewing information about wildlife mortality at wind facilities

Greater Sage-Grouse

The greater sage-grouse, a candidate for listing under the U.S. Endangered Species Act, ranges across 11 western states and 2 Canadian provinces. Population declines, caused by the loss of suitable sagebrush habitat to meet requirements for food, cover, and nesting, remain an issue. The effects of wind development add to other factors that can influence sage-grouse, including rangeland fire, climate change, invasive plants, disease, and land use.

Scientists at FRESC have worked for several decades to describe sage-grouse distribution, abundance, habitat, and trends, and have established a foundation for evaluating other influences. For example, FRESC is identifying sage-grouse populations at risk of extinction due to isolation from other populations, wind developments, and other changes. This work involves analyses of genetic and landscape characteristics in sage-grouse populations that will help determine the probability that sage-grouse will disperse to stable sites. The research will help focus regional conservation and land management in priority areas that are likely to sustain long-term sagebrush ecosystems.

Greater sage-grouse

FRESC is also studying the probability that vulnerable populations could be connected to neighboring populations through dispersal to enhance long-term viability. Scientists are analyzing genetic characteristics of sage-grouse populations relative to landscape features to get this information. Results could be used to focus conservation in priority areas that are likely to sustain sagebrush ecosystems, and to focus land uses in areas that are less suitable for sage-grouse.

Mitigation Options

Mitigation is defined as any action that is taken to reduce, avoid, or compensate for any adverse effects. The development and testing of mitigation measures is important to wind industries. Effective mitigation programs require a sizeable body of knowledge about potential effects on the resources of concern, whether the effect can be mitigated, and if so, what actions can be taken and how effective those actions are. For example, many migratory species follow specific routes, in some cases following topographic features that funnel wind currents.

Wind-energy developers also take advantage of topography and wind currents to locate facilities. To balance conservation of wildlife and energy development may mean that operations or siting may be changed to minimize effects. It also might involve minimizing mortality or injury due to factors other than wind facilities.

Relationship between Bat Activity and Fatality

Using bats as an example, FRESC is conducting research to relate bat fatality at wind-power facilities to actual bat activity and to weather patterns. Defining these relationships is important because the first step in minimizing negative effects of wind turbines is proper siting of projects in areas with low risks to bats. One potential measure of risk is the level of bat activity in the anticipated rotor-sweep area. The direct relationship between bat activity in this area and fatality has not been shown, yet the assumption of a direct relationship underlies many management decisions. If there is a direct relationship, then areas of high activity identified in pre-construction monitoring can be assumed to also be areas of high risk of fatality in post-construction operations. If the predictive relationship can be further refined by incorporating weather variables, it might suggest options that could further reduce fatalities once a facility is operational.

Monitoring and Analysis

Systematic ecological monitoring is a critical component of wind development because it provides the information to evaluate change through periods of time and across different geographic areas. It also provides the information needed for adaptive management. Many types of site-specific monitoring techniques are used at wind facilities, so the information cannot be readily integrated to support landscape and regional analysis or to evaluate change through time. Resource managers also seek early warnings of change so that operations can be adjusted if there will be negative effects. Coupled with this, managers need monitoring approaches that can be used to evaluate the effectiveness of any mitigation strategies used to reduce negative effects.

Standardized Monitoring Methods

Scientists at FRESC are helping managers design and test uniform sampling protocols for monitoring at wind facilities. Additionally, they are analyzing data collected in monitoring programs, synthesizing information, and monitoring management and mitigation outcomes. For example, scientists are collaborating with managers to use radio telemetry and other tracking methods to obtain data about eagles, and also are developing and testing new survey methods. Satellite telemetry can provide regular indications of the likelihood of eagle mortality and indicate when to launch efforts to find carcasses in time to assess cause of mortality. Most of these survey and monitoring methods are applicable to other birds of prey and other species that are commonly distributed across a wide area.

USGS scientist monitoring golden eagles

Other Topics for Research and Technical Assistance

FRESC is known for its broad science program covering ecosystem ecology, landscape ecology, restoration and management of ecological systems, conservation biology, and inventory and monitoring research and development. All of these topics have relevance to wind energy. The understanding of distribution and abundance patterns of wildlife naturally leads to questions about relations between wildlife populations and their habitats. It also leads to questions about how wind facilities directly affect population abundance, patterns of population distribution, and interconnections between populations. There are additional questions about how much otherwise suitable habitat becomes unavailable with development of existing and potential wind sites and additional questions about mitigation options, including what forms of mitigation are suitable for given objectives and where mitigation might work best for the affected wildlife.

Many other species besides birds and bats may also be affected by wind-energy development. They include mammals; invertebrates, such as butterflies; plants; and a wide variety of other species. Ecosystem coverage includes arid lands, grasslands, mountain tops and passes, coastlines, and oceans. FRESC will continue to maintain a highly flexible and adaptive infrastructure so that it can be responsive and effective in anticipating and addressing the issues associated with wind energy and natural resource conservation and management.

For more information:

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