

# European Wolves and Wind Energy Development

## THE SPECIES

Gray wolf (*Canis lupus*) is one of the most well-known and studied species because of its close and ancient relationship with humans. Wolves occur throughout the northern hemisphere, inhabiting a variety of habitats that range from Arctic tundra to Arabian deserts. They often live in human-dominated landscapes, particularly in Southern Europe and Asia. Wolves live in family groups; each pack defends a wide and well-defined territory, in which they hunt and reproduce. Births occur in late spring and pups stay within home sites all summer, in close proximity to the den.

Wolves are opportunistic carnivores that feed mostly on wild ungulates. Nonetheless, domestic prey such as cattle, horses, goats, and sheep can be an important part of this carnivore's diet in many countries. Livestock depredations by wolves create strong conflicts with human interests, leading to high levels of legal and illegal human-caused

wolf mortality. Worldwide the species is not considered to be of conservation concern, because of the presence of large populations in Canada, Alaska, and Russia. However in Europe, particularly in the European Union, wolves are considered a priority species for conservation (Habitats Directive 92/43/EEC – Annexes II and IV); European Union member states are required to designate and manage specific areas for species conservation.

## MAIN RISKS AND EFFECTS

Large carnivores, such as wolves, tend to avoid areas that are regularly used by humans, especially when breeding; they show a preference for rugged and undisturbed areas, such as mountain ridges. These areas are often characterized by good wind resources and are chosen for wind energy development. Although wolves are a very adaptable species, they can only cope with a certain level of human disturbance, particularly around breeding sites.



The biggest concern for wolves around wind farms is increased human disturbance in otherwise remote areas that are of particular importance for breeding packs.

Research conducted in Portugal, where wind farms are mainly installed on mountain ridges, has shown a significant increase in vehicle traffic on wind farm road networks during farm construction and operation, compared to pre-construction periods—up to 200 times higher traffic during construction and 11 times higher during operations. As a result, wolf populations are being excluded from wind farm areas during farm construction and the first years of farm operation, thereby resulting in changes in the use of habitat and decreased reproductive rates. However, the magnitude of these effects is lessened as operations continue and resident wolves adapt to the new infrastructure.

In addition, wind farms induce changes in the wolves' selection of and fidelity to sites used during the birthing and pup-rearing periods. When wind turbines are built within 3 km of breeding areas or home sites, major shifts in the denning locations have been recorded the following year, in some cases involving displacements greater than 6 km. This behavioral response of breeding wolves to windfarms might not be problematic in areas that have large patches of suitable habitat, but in areas of heterogeneous and human-dominated landscapes, conservation concerns have been raised. In particular, the areas suitable for breeding may be limited, and the cumulative effects of other threats, such as additional infrastructure and human-caused mortality, may affect the wolf populations. There is evidence of these effects for endangered wolf populations in Portugal, which are estimated to include approximately 60 breeding packs.

## MONITORING IMPACTS

To evaluate the effect of wind farms on critical spaces used by wolves, BACI (Before-After-Control Impact) survey designs are used in a grid cell study area centered on the wind infrastructure. Parameters such as the presence/absence and relative abundance of wolves are analyzed throughout the grid cells over time (pre- and post-construction) to test for significant differences in habitat use, and to relate the number of wolves to the scheduling of wind farm construction and operations. Wolf monitoring can be done with noninvasive methods based on scat surveys and camera trapping, or with more invasive approaches such as telem-

etry, which can provide fine-scale data on movements, activity, and habitat use in relation to wind farm construction schedules. Howling stations are normally used to confirm breeding areas and reproductive success.

## MITIGATION AND COMPENSATION MEASURES

Because habitat disturbance and shifts in denning sites are the main reported effects of wind farms on wolves, mitigation measures tend to address these factors. Natural buffers from known denning areas (2 to 3 km) have been used, with consequent alteration in the wind farm layout. Gates or other types of road barriers have been tested to minimize road traffic and human presence within the wind farm.

Several compensation measures have been applied in Portugal, implemented at local and regional scales (from nearby breeding sites to the entire wolf range). These measures have been mostly related to habitat management such as promotion of suitable conditions for wolf breeding, recovery of wild prey populations, and actions that decrease the level of conflict through promotion of damage-prevention measures such as using electric fences and dogs to guard livestock.

## RESEARCH PRIORITIES

Well-designed, long-term studies that emphasize coupling wind farm and cumulative impacts from other infrastructure or human activities are needed to provide reliable insights into wind farm-wolf dynamics. In addition, population-level impacts on wolves could be better resolved with regional monitoring studies, compared to current studies that are generally locally based.

Wolf populations have been expanding in Europe, which increases the need for surveys that evaluate the distance from operational wind farms at which wolves can reproduce successfully, in addition to surveys of resident wolves during wind farm construction. There is little understanding of the potential effects of the visual and acoustic presence of wind farms on wolves, which could be clarified by further research.

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For more information, go to <https://tethys.pnnl.gov/short-science-summary-european-wolves-and-wind-energy-development>

