

## Barrier Effect

A barrier, by definition is a tangible (e.g., wind facility) or an intangible (e.g., radiation or infrasound) disturbance that restricts the free movement, mingling, or interbreeding of individuals or populations of a species (Merriam-Webster Online Dictionary). The barrier is another consideration to address when locating and designing wind facilities. For avifauna, the barrier effect occurs when a bird's avoidance of a wind facility results in an increase in energy use to circumvent the turbine area (Goodale and Divoll 2009). The level of impacts from barrier effect varies dependent on species presence, turbine layout, wind facility size, season, and the birds' ability to compensate for energetic losses (Langston and Pullan 2003, Fox et al. 2006). Though population-level impacts currently have not been observed from this effect, there is concern that blockage between breeding and feeding areas may have significant impacts (Fox et al. 2006, Goodale and Divoll 2009, Drewitt and Langston 2006). The combined barrier effect of multiple adjoining wind facilities is also a concern as wind development becomes more prevalent (Drewitt and Langston 2006).

The barrier effect has been well documented in several offshore wind projects (Guarnaccia and Kerlinger 2007) where avoidance behaviors by various bird species have been recorded at distances of between approximately 330 feet and 1.9 mi from turbine arrays (Drewitt and Langston 2006, Exo et al. 2003, Tulp et al. 1999, Christensen et al. 2004, Kahlert et al. 2005, Pettersson 2005, Desholm and Kahlert 2005, Percival 2001). Some reports even show avoidance of up to 2.5 mi by several waterbirds (Kuvlesky et al. 2007).

Barrier effects from land-based wind energy developments have been less frequently observed, but have been documented. In a 4-year monitoring program of 6 land-based wind facilities in the Beauce Region of France, preliminary results showed that 70-99% of migrating birds changed path a few hundred yards out to avoid the wind facilities, especially where turbines were densely clustered (European Commission 2010). Avoidance may also occur as the result of noise or habitat loss due to construction of roads and other structures associated with facility development (Fox et al. 2006). In results from a land-based facility in Carbon County, WY, Johnson et al. (2000) recorded a decrease in the population of mountain plovers between 1998 and 1999, which could be attributable to behavioral avoidance by this species. Decreased use of the site during construction by raptors and larks was also observed at this WY site. In a pre- and post-construction comparison study of Golden Eagle use of a wind facility in Argyll, Scotland, a pair of resident Golden Eagles altered their ranging behavior to avoid the entire wind facility area post-construction, except when intercepting intruding birds (Walker et al. 2005). Bald Eagles displayed similar behavior after the construction and operation of a 3-turbine wind facility in Pillar, Alaska (Kodiak Island) where Eagles discontinued use of previously utilized areas of the mountain ridge in order to avoid crossing the ridge among the turbines (Sharp et al. 2010).

The long term impacts of barrier effects are still uncertain, and further research is needed to address this issue (Goodale and Divoll 2009). However, given the mounting evidence of avoidance effects resulting from both on- and offshore wind development, and the possibility of population effects over time (Drewitt and Langston 2006), wind developers need

to carefully assess the potential impacts to species prior to and following development. This must include a determination of the birds, bats and other species that utilize the site and adjacent habitats. Long lines of turbines and large turbine arrays may be problematic as they present a larger barrier (Goodale and Divoll 2009, Drewitt and Langston 2006). Layout modification such as creating flight corridors or placing turbines closer together to reduce the project footprint have been suggested as approaches to help minimize impacts (Drewitt and Langston 2006). However, impacts can be site specific, and may not occur at each site (Goodale and Divoll 2009). Therefore, turbine layout and facility location should be evaluated on a site-specific basis by an experienced wildlife biologist in conjunction with information regarding local and migratory bird and bat species in, around or passing through the proposed site to ensure that any possible barrier effects are minimized or avoided.

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