

GOLDEN EAGLE MORTALITY AT A WIND-ENERGY FACILITY NEAR PALM SPRINGS, CALIFORNIA

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Wind-energy development is proceeding rapidly worldwide, including in the United States. Yet we still know rather little about the direct and indirect (Katzner et al. 2013) environmental effects of renewable-energy development and operation (Hernandez et al. 2014), especially the negative effects on wildlife (Lovich and Ennen 2011, 2013). Birds and bats are particularly sensitive (Kuvlesky et al. 2007) through collisions with turbines and other equipment (Cohn 2008). Loss et al. (2013) suggested that 140,000–328,000 birds are killed annually by monopole turbines in the United States. On the basis of an installed capacity of 51,630 MW of energy in 2012, Smallwood (2013) estimated the annual fatality in the United States at 888,000 bats and 573,000 birds, including 83,000 raptors.

The Bald Eagle (*Haliaeetus leucocephalus*) and Golden Eagle (*Aquila chrysaetos*) are of particular concern as victims of collisions with wind-energy turbines because of legal, societal, and biological factors. Both species are protected under the Bald and Golden Eagle Protection Act of the United States (Iraola 2005), have a charismatic standing in society, are used by Native Americans for religious purposes (Kochert and Steenhof 2002), and are the national birds of the U.S. and Mexico, respectively. This symbolism generates public concern for their well-being in North America and beyond. Furthermore, as long-lived apex predators, eagles are characterized by low natural population densities and reproductive rates and therefore are especially sensitive to additive mortality (Kochert and Steenhof 2002, Whitfield et al. 2004).

In spite of these concerns, data on eagle mortality at wind-energy facilities in the contiguous United States are generally scarce, except for the Altamont Pass Wind Resource Area in central California. In this area, the average annual mortality of the Golden Eagle from 1998 to 2002 has been estimated at 67 (80% confidence interval 25–109; Smallwood and Thelander 2008; see also Drewitt and Langston 2006), after adjustment for carcasses' detectability and removal by scavengers. In their review of the available data, Pagel et al. (2013) noted that when data from Altamont Pass were excluded, a minimum of 79 Golden and six Bald Eagles were reported killed at 32 wind farms in 10 states from 1997 to 30 June 2012. Pagel et al. (2013) observed "assessments of eagle mortality at commercial-scale and/or private wind energy facilities are either seldom conducted or in some cases not made available for public review." In light of the dearth of documentation of Golden Eagle mortality at wind farms, I report details of two cases near Palm Springs, California.

The study site is one of many utility-scale wind-energy facilities in the San Geronio Pass, about 13 km northwest of Palm Springs. It is situated in the southeastern foothills of the San Bernardino Mountains at elevations from about 600 to 900 m. Known as the Mesa Wind Project Site (Diffendorfer et al. 2014), or Mesa, the facility was one of several the Bureau of Land Management permitted on public land in 1983 (Lovich et al. 2011a), in addition to numerous installations on private land in the area (Diffendorfer et al. 2014). Construction at Mesa eventually resulted in completion of 460 turbines, 51 electrical transformers, a substation, a maintenance building, and an extensive network of unpaved roads (Lovich and Daniels 2000). Turbines are 65-kW units mounted on lattice towers either 24.4 or 42.7 m tall, with rotors 8 m in diameter and a swept area of 177 m². The site is located at the western extremity of the Colorado Desert where it blends with other plant communities from the Mojave Desert, chaparral, and coastal sage scrub ecosystems. The vegetation is generally desert scrub and has been burned several times over the last 20 years (Lovich et al. 2011b). The Golden Eagle's prey, including lagomorphs (*Lepus californicus*,

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Sylvilagus audubonii) and rodents, especially the California ground squirrel (*Otospermophilus beecheyi*), are seasonally abundant at the site.

I did not survey the site systematically for avian mortality; avian observations were incidental to long-term studies of the ecology and behavior of Agassiz's desert tortoise (*Gopherus agassizii*), primarily 1997–2000 and 2009–2014 (Lovich et al. 2011a). The research generally involved visiting the site once every 7–10 days from April to July for one or two days. Crews of 1–8 people walked long, meandering transects looking for tortoises to equip with transmitters or radio-tracking tortoises already outfitted for telemetry. Some aspects of the study required daily field work with one or two people. When dead birds were observed, field notes and photographs were taken opportunistically. Since research was not focused on birds, and bird carcasses were found incidentally, it is likely that avian mortality and injury were underestimated at the site.

The first eagle mortality was observed on 31 August 1995. A maintenance worker told me that he found an immature eagle that was hit and killed by a turbine on one of the 24.4-m towers. When I examined the carcass, it was on the ground, cut in half by the tip of a turbine blade. I reconsolidated the carcass pieces for photographic documentation (Figure 1). The tip of the turbine blade was clearly stained with blood and feathers (Figure 2). Time since death was not known, but the condition of the carcass suggested up to several days.

The second eagle, a subadult female, was observed 17 April 1997 when maintenance workers alerted me to an injured eagle, struck by a turbine on a 24.4-m tower at 15:30. I arrived at the site after 16:05 with a biologist from the California Department of Fish and Game, and we found the immature female eagle alive but unable to fly. We captured it and delivered it to a wildlife-rehabilitation center in the nearby Coachella Valley, where it was found to be injured so severely that it was euthanized. Both fatalities were reported to the Bureau of Land Management, California Department of Fish and Game, and U.S. Fish and Wildlife Service. During my tortoise research, I noted additional avian mortality near turbines, including at least three Red-tailed Hawks (*Buteo jamaicensis*).



Figure 1. Immature Golden Eagle (*Aquila chrysaetos*) killed after being struck by a turbine blade at a wind farm near Palm Springs, California.

Photo by Jeffrey E. Lovich

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Figure 2. The turbine that killed the Golden Eagle shown in Figure 1. Blood and feathers could clearly be observed on the tip of the blade to the right and the stains are visible in this photograph.

Photo by Jeffrey E. Lovich

Mortality of the Bald Eagle has been reported at wind farms in Maryland, Iowa, and Wyoming, but mortality of the Golden Eagle has been reported only west of the Mississippi River (Pagel et al. 2013). The second highest incidence of Golden Eagle mortality from 1997 to 2012 was reported from California ($n = 27$, excluding Altamont Pass), a total exceeded only slightly by Wyoming ($n = 29$) during the same time period (Pagel et al. 2013). According to Pagel et al., because of the lack of rigorous monitoring and reporting, their totals “likely underestimate, perhaps substantially, the number of eagles killed at wind energy facilities in the United States.” Hunt (2002) studied survivorship of 257 radio-tagged Golden Eagles at Altamont Pass for seven years. Among those, 100 deaths were observed, including a minimum of 42 attributed to wind turbines. According to Hunt (2002), lattice-style turbine towers are more dangerous to Golden Eagles than other towers, including tubular monopoles. All 460 of the towers at Mesa are lattice-style.

I was unable to find any peer-reviewed journal articles specifically documenting other Golden Eagle mortalities at my study site. The 1997 mortality I observed appears to be included in the California tally of Pagel et al. (2013). The same eagle was mentioned in a technical report by Anderson et al. (2005) without the details I provide. The 1995 mortality was not included in either source. Anderson et al. (2005) summarized the results of avian monitoring and risk assessment at several sites in the San Geronio Pass, including Mesa, from 1997 to 2000. McCrary et al. (1983) estimated that 6800 birds were killed by turbines annually in the San Geronio Pass in the early 1980s and that 69 million birds pass through the surrounding Coachella Valley annually during migration. On the basis of this ratio, those reports concluded that the effects of the wind farms on birds in the area were insignificant.

During phase I of their studies from 1997 to 1998, Anderson et al. (2005) reported 61 fatalities (due to turbines or unknown causes) of 19 species, including the 1997 eagle mortality I detail here. Most of the dead birds were found near turbines. During phase II from 1999 to 2000 they found 31 unknown or turbine-related fatalities of 12 species. Notably, they observed “10 groups of 13” (without providing more details) live Golden Eagles near turbines during their surveys in 1997 and 1998 but

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none in 1999 or 2000. Other raptor carcasses found included Red-tailed Hawks and unidentified owls. Not adjusting their results for scavenging by predators, Anderson et al. estimated raptors' fatality rate at 0.006/turbine/year throughout the San Geronio Pass, or 0.03 raptor fatalities/MW/year. Their rates were lower than the unadjusted rates reported by Smallwood and Thelander (2008) at Altamont Pass. Adjusting for scavenging is important, as Anderson et al. noted that 90% of chicken carcasses placed in the San Geronio Pass study area disappeared from scavenging within 10 days. If surveys were repeated at longer intervals, it is likely the majority of carcasses would be missed (see also Smallwood 2007).

Eagles observed occasionally at Mesa often flew at altitudes well within the range of heights covered by the turbines and within the area swept by the blades, exposing them to the risk of collision. From 2009 to 2014 the only sighting at Mesa was of one on 10 May 2011 (M. Agha pers. comm.). Other sightings in the San Geronio Pass have been reported since 2008, including one in 2014 (P. Unitt pers. comm.). Since no systematic surveys have been conducted or published other than those cited here, the eagle's frequency of occurrence in the area remains unclear. My casual observations suggest a decline, as also observed by Anderson et al. (2005) from 1997 to 2000. Better studies of the effects on wildlife of renewable-energy development are needed (Lovich and Ennen 2011, 2013).

Although two eagle deaths may seem insignificant, my incidental observations represent over 2% of all Golden Eagle mortalities reported nationally (Altamont Pass excluded) by Pagel et al. (2013) from 1997 to June 2012. Pagel et al. reported 79 Golden Eagles killed over 32 facilities over 15.5 years, a rate of 0.16 mortalities per facility per year. Minimizing wildlife mortality at wind farms is a major goal of conservation (USFWS 2013), although research on how best to do that is in short supply (Kuvlesky et al. 2007, Lovich and Ennen 2013). Compiling and publishing accurate data on mortality of Golden Eagles over time is an important first step in efforts to protect these iconic birds.

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