

Smallwood, K.S., L. Ruge, M.L. Morrison. 2009. Influence of Behavior on Bird Mortality in Wind Energy Developments. *Journal of Wildlife Management* 73(7):1082-109

Abstract: As wind power generation is rapidly expanding worldwide, there is a need to understand whether and how preconstruction surveys can be used to predict impacts and to place turbines to minimize impacts to birds. Wind turbines in the 165-km² Altamont Pass Wind Resource Area (APWRA), California, USA, cause thousands of bird fatalities annually, including hundreds of raptors. To test whether avian fatality rates related to rates of utilization and specific behaviors within the APWRA, from March 1998 to April 2000 we performed 1,959 30-minute behavior observation sessions (360° visual scans using binoculars) among 28 nonoverlapping plots varying from 23 ha to 165 ha in area and including 10–67 turbines per plot, totaling 1,165 turbines. Activity levels were highly seasonal and species specific. Only 1% of perch time was on towers of operating turbines, but 22% was on towers of turbines broken, missing, or not operating. Of those species that most often flew through the rotor zone, fatality rates were high for some (e.g., 0.357 deaths/megawatt of rated capacity [MW]/yr for red-tailed hawk [*Buteo jamaicensis*] and 0.522 deaths/MW/yr for American kestrel [*Falco sparverius*]) and low for others (e.g., 0.060 deaths/MW/yr for common raven [*Corvus corax*] and 0.012 deaths/MW/yr for turkey vulture [*Cathartes aura*]), indicating specific behaviors or visual acuity differentiated these species by susceptibility to collision. Fatality rates did not correlate with utilization rates measured among wind turbine rows or plots for any species except burrowing owl (*Athene cunicularia*) and mallard (*Anas platyrhynchos*). However, mean monthly fatality rates of red-tailed hawks increased with mean monthly utilization rates ($r^2 = 0.67$) and especially with mean monthly flights through turbine rows ($r^2 = 0.92$). Fatality rates increased linearly with rates of utilization ($r^2 = 0.99$) and flights near rotor zones ($r^2 = 1.00$) for large raptor species and with rates of perching ($r^2 = 0.13$) and close flights ($r^2 = 0.77$) for small non-raptor species. Fatalities could be minimized or reduced by shutting down turbines during ≥ 1 season or in very strong winds or by leaving sufficiently large areas within a wind farm free of wind turbines to enable safer foraging and travel by birds.