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Executive Summary: It has been estimated that from 100 million to well over 1 billion birds are killed annually in the United States due to collisions with human-made structures, including vehicles, buildings and windows, powerlines, communication towers, and wind turbines. Although wind energy is generally considered environmentally friendly (because it generates electricity without emitting air pollutants or greenhouse gases), the potential for avian fatalities has delayed and even significantly contributed to blocking the development of some windplants in the U.S. Given the importance of developing a viable renewable source of energy, the objective of this paper is to put the issue of avian mortality associated with windpower into perspective with other sources of avian collision mortality across the U.S.

We have reviewed reports indicating the following estimated annual avian collision mortality in the United States:

- Vehicles: 60 million - 80 million
- Buildings and Windows: 98 million - 980 million
- Powerlines: tens of thousands - 174 million
- Communication Towers: 4 million - 50 million
- Wind Generation Facilities: 10,000 - 40,000

The large differences in total mortality from these sources are strongly related to the differences in the number (or miles) of structures in each category. There are approximately 4 million miles of road, 4.5 million commercial buildings and 93.5 million houses, 500,000 miles of bulk transmission lines (and an unknown number of miles of distribution lines), 80,000 communication towers and 15,000 commercial wind turbines (by end of 2001) in the U.S. However, even if windplants were quite numerous (e.g., 1 million turbines), they would likely cause no more than a few percent of all collision deaths related to human structures.

There are also other sources that contribute significantly to overall avian mortality. For example, the National Audubon Society estimates avian mortality due to house cats at 100 million birds per year. Pesticide use, oil spills, electrocution, disease, etc. are other significant sources of unintended avian mortality. Due to funding constraints, the scope of this paper is limited to examining only fatalities resulting from collisions with human-made obstacles. Recognize that the cumulative impacts of all mortality factors on birds continue to increase as the human population climbs and resource demands grow. Every effort by all industries to reverse avian mortality trends and minimize the number of bird deaths is important.

Many of the studies of buildings, communication towers, and powerlines were conducted in response to known or perceived problems with avian collisions, and therefore may not be representative of all structures in the United States. As a consequence, using averages of these estimates to project total avian fatalities in the U.S. would be biased high. The estimates provided for the sources of avian mortality listed above, except wind generation facilities, are based on subjective models and are very speculative.

In contrast to other sources of avian collision mortality, avian hazards at most windplants have been evaluated using more standardized methods, and studies have often been conducted without regard to a known or perceived risk. Fatality estimates from wind generation facilities, especially new facilities, have typically considered adjustments for scavenging and observer detection biases. These biases were generally not considered or calculated in studies estimating avian mortality due to collisions with communication towers, vehicles, and buildings and windows. Therefore, the data available to project overall windplant fatalities are generally more accurate than most available data for other collision sources.

Data collected to date indicate an average of 2.19 avian fatalities per turbine per year in the U.S. for all species combined and 0.033 raptor fatalities per turbine per year. Based on current projections of 15,000 operational wind turbines in the U.S. by the end of 2001, the total annual mortality was estimated at approximately 33,000 bird

fatalities per year for all species combined. This estimate includes 4,500 house sparrows, European starlings and rock doves, and 488 raptor fatalities per year. We estimate a range of approximately 10,000 to 40,000 bird fatalities. The majority of these fatalities are projected to occur in California where approximately 11,500 operational turbines exist, and most are older smaller turbines (100- to 250-kW machines). Data collected outside California indicate an average of 1.83 avian fatalities per turbine per year, and 0.006 raptor fatalities per turbine per year. Based on current projections of 3,500 operational wind turbines in the U.S. by the end of 2001, excluding California, the total annual mortality was estimated at approximately 6,400 bird fatalities per year for all species combined. This estimate includes 400 house sparrows, European starlings, and rock doves, and 20 raptor fatalities per year. While there have been numerous single mortality events recorded at communication structures that document several hundred avian fatalities in one night, the largest single event reported at a wind generation facility was fourteen nocturnal migrating passerines at two turbines at the Buffalo Ridge, Minnesota, Windplant during spring migration. Based on current estimates, windplant-related avian collision fatalities probably represent from 0.01% to 0.02% (i.e., 1 out of every 5,000 to 10,000 avian fatalities) of the annual avian collision fatalities in the United States. While some may perceive this level of mortality as small, all efforts to reduce avian mortality are important.

Making projections of the potential magnitude of windpower-related avian fatalities is problematic because of the relative youth of the wind industry and the resulting lack of long-term data. For example, of the existing windplants, only the Altamont Pass, Buffalo Ridge and Foote Creek Rim wind resource areas(WRA) have been studied for more than two years, and most of the studies at Altamont focused on raptor mortality. The data collected at Altamont and other older-generation windplants may not be representative of avian mortality of future wind developments. Newer generation windplants incorporate improvements in site planning and changes in the design of the wind turbines. For example, turbines at the Foote Creek Rim Windplant were moved back away from the rim edge because baseline data detected a pattern of raptor use along the edge of the rim (Johnson et al. 2000a). Also, many of the newer generation turbines are designed to provide little perching and no nesting structure (tubular towers, enclosed nacelle). Although it's not clear that perching increases risk of collision, the lack of perching and nesting opportunities may discourage some bird species from using the WRA. Furthermore, some efforts have been made in Altamont to remove turbines associated with higher raptor mortality, and re-powering efforts may result in the replacement of many of the older, smaller turbines with fewer larger, newer generation turbines. If these efforts effectively reduce raptor mortality at Altamont, our raptor mortality projections would also be reduced. Finally, most wind plant developers are required to carry out site evaluations at proposed wind plant sites to determine impacts on birds and other wildlife. While newer generation turbines may be considered more representative of future developments, they have only been in operation in the recent past (i.e. <10 years), and less information on avian collision hazards is available for these turbines.