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TECHNICAL MEMORANDUM

DATE: October 10, 2018

TO: Kristen Goland, Pacific Wind Development LLC

FROM: Quentin Hays, Andrea Chatfield, and Joel Thompson, WEST, Inc.

RE: Nocturnal Migrant Risk Summary, Fountain Wind Project, Shasta County, CA

Introduction

Passerines are the most abundant bird group in many terrestrial ecosystems, and are the most commonly reported fatalities at wind energy facilities (NRC 2007, Erickson et al. 2014). Many species of passerines migrate at night, creating the potential for collision with tall man-made structures (Gehring et al. 2011). To address concern over potential impacts to nocturnal migrant bird species at the Fountain Wind Project (Fountain), Pacific Wind Development LLC (Pacific Wind) contracted Western EcoSystems Technology, Inc. (WEST) to conduct a review of risk to nocturnal migrant birds at wind energy facilities, and to evaluate the need for nocturnal radar studies at Fountain. The following memorandum summarizes the current information on collision impacts to nocturnal migrants both nationally and locally, and reviews the efficacy of using radar studies to assess risk to nocturnal migrants at wind energy facilities.

Nocturnal Migrant Fatality Rates

Avian collision fatality data from studies conducted at 30 wind energy facilities across North America were examined to estimate how many nocturnal migrants collide with turbines and towers (Kerlinger et al. 2010). Fatality rates of nocturnal migrants at turbines ranging in height from 54 to 125 meters (m; 117 to 410 feet [ft]), adjusted for scavenging and searcher efficiency, ranged from less than one bird/turbine/year to approximately seven birds/turbine/year, with generally higher rates recorded in eastern North America and lower rates in the West. Multi-bird fatality events (i.e., an event defined as more than three birds killed in one night at a single turbine) were extremely rare (Kerlinger et al. 2010). The largest mortality events attributed to turbines at U.S. wind energy facilities to date include 14 migrant passerines found at two turbines during spring migration at Buffalo Ridge, Minnesota (Johnson et al. 2002), and 27 migrants at the Mountaineer facility in West Virginia (Kerns and Kerlinger 2004). The West Virginia fatalities apparently are believed to have occurred during inclement weather and at a turbine near an illuminated substation. These findings are in contrast to avian collisions with other tall structures such as communication towers and buildings where single-night, single-

tower casualty events of hundreds to thousands of individuals have been reported (Longcore et al. 2012, 2013, Loss et al. 2014, 2015). The limited number of migrant fatalities at wind energy facilities compared to other tall structures is best explained by the types of lighting employed. Nearly all multi-bird nocturnal avian migrant fatality events are detected at tall structures with non-flashing lights, such as communications towers and buildings (Longcore et al. 2012, 2013, Loss et al. 2014, Johnson et al. 2016), and are nearly always associated with inclement weather. During storms, birds may become disoriented and are attracted to non-flashing lights (Kerlinger 2000, Gauthreaux and Belser 2006). The type of lighting associated with multi-bird fatality events (i.e., non-flashing lights) are not used on wind turbines; flashing red lights are installed at the top of wind turbines (Gehring et al. 2009, Kerlinger et al. 2010). Multi-bird fatality events rarely occur at wind energy facilities, and appear to occur when wind energy facilities are inadvertently lit at night (e.g., Stantec 2011).For these reasons, and based on the absence of non-flashing lights as well as implementation of lighting best management practices at modern wind energy facilities (i.e., down shielding, use of timers), it is reasonable to expect that multi-bird fatality events at wind energy facilities in North America will continue to be extremely rare.

During a study of four wind energy facilities located within a major migration flyway in Germany, Welcker et al. (2016) recorded bird flight intensities using radar while simultaneously conducting systematic searches for collision fatalities. Passage rates established by radar were significantly higher during the night than during the day, yet strictly nocturnal migrants constituted only 8.6% of avian fatalities documented during the study. The authors conclude that, in contrast to the situation at other vertical structures, nocturnal migrants do not have a higher risk of collision with wind turbines than do diurnally active species, but rather, appear to circumvent collision more effectively (Welcker et al. 2016). Similarly, Krijgsveld et al. (2009) found the collision risk of nocturnal migrants (27% of fatalities documented) to be an order of magnitude lower than that of diurnally active and resident birds. These results suggest that, while the proportion of nocturnal migrant fatalities may vary considerably from site to site, nocturnally migrating birds are not generally more susceptible to collision with wind turbines compared with diurnally active birds.

Potential risk to migrant passerines at Fountain may be best characterized by avian mortality data from the Hatchet Ridge Wind Energy Facility (Hatchet Ridge), located immediately to the northeast of Fountain. Based on the three-year fatality monitoring study at Hatchet Ridge (2010-2013), seasonal avian mortality was observed to be low, with annual small bird fatality rates ranging from 0.31 to 2.03 fatalities/megawatt (MW)/year and estimated annual large bird mortality ranging from 0.47 to 0.52 fatalities/MW/year (Tetra Tech 2014). Of a total of 129 bird fatalities documented during the three-year monitoring study, only 33 (25.6%) were potential nocturnal migrants (i.e., small bird fatalities occurring in spring and fall comprising species know to be nocturnal migrants in the region). This is a conservative estimate, as most of the 18 small bird species documented as fatalities at Hatchet Ridge are also known summer or year-round residents of the site and it is likely that at least some of the fatalities that occurred in spring and fall were local resident birds rather than migrating birds. During non-migration seasons (summer and winter), small bird species accounted for 13.2% of total bird fatalities at Hatchet Ridge. The results of the Hatchet Ridge fatality study suggest generally low risk to passerines and other small bird species and no apparent disproportionate impacts to nocturnal migrants at the facility.

Due to the proximity of Fountain to Hatchet Ridge, as well as similar topographic and habitat characteristics at the two sites, impacts to nocturnal migrants at Fountain are expected to be similarly low.

Efficacy of Nocturnal Radar Studies

Nocturnal radar studies are a method that may be used to characterize passage rates and flight altitudes of nocturnal migrants, particularly passerines (Kerlinger 1995). At the adjacent Hatchet Ridge facility, a nocturnal radar study was conducted during the fall of 2007 (Mabee and Sanzenbacher 2008), during which an average passage rate of 290 ± 26 targets/kilometer/hour (km/hr) was recorded. During the study, the average altitude of targets was 468 ± 3 m above ground level (AGL), with only 8% of targets flying below the proposed turbine height (i.e., 125 m AGL); 92% of recorded targets during this study were not exposed to collision risk. At the proposed Bear River Ridge Wind Project located approximately 200 km to the west of Fountain, a nocturnal radar study conducted in the fall of 2006 found similar trends, with an average passage rate of 269 ± 11 targets/km/hr and an average altitude of 329 ± 2 m AGL (11% of targets below 125 m [Sanzenbacher et al. 2007]). Results from radar studies at proposed wind projects in Oregon, Washington, and Idaho have found fall passage rates ranging from 19 – 269 targets/km/hr, and average fall altitudes of 472 – 647 m AGL (Cooper et al. 2004, Mabee and Cooper 2000a, 2000b, 2002, 2004), well above the height of wind turbines. Numerous nocturnal radar studies in the eastern U.S. have documented similar patterns, with fall passage rates ranging from 64 – 661 targets/km/hr, and mean flight heights ranging from 333 to 532 m AGL (see Appendix 6 in Mabee and Sanzenbacher 2008). Given the abundance of such data locally (i.e., Hatchet Ridge), regionally, and across the U.S., it is unlikely that migration patterns would be substantially different at Fountain; the large majority of nocturnal avian migrants would be expected to fly well above the height of commercial wind turbines.

Although numerous nocturnal radar studies have been conducted at sites proposed for wind energy development, the results from these studies have demonstrated limited utility in assessing risk to nocturnal migrants. While radar can be a useful tool to study nocturnal avian migration patterns, no correlation exists between pre-construction radar studies and post-construction fatality estimates. Based on an analysis of 15 seasonal nocturnal migration studies conducted at wind energy sites between 1999 and 2009, no correlation was found between pre-construction passage rates and flight heights, and post-construction fatality estimates (Tidhar et al. 2010). Stantec (2017) analyzed the relationship between publicly available pre-construction radar studies and post-construction fatality data at 20 wind energy facilities in Maine. Those results showed no correlation between the pre-construction radar data (including both passage rate and percentage of target below turbine height) and the level of post-construction avian mortality documented at each site (Stantec 2017).

Radar-Driven Turbine Curtailment as a Case Study

Collision risk to nocturnal migrants has been of particular concern at wind energy facilities along the Texas Coast because of the importance of the region as a migratory corridor (i.e., for trans-Gulf migrants; Morrison 2006). Because of this concern, and as a proactive minimization measure, Pacific Wind committed to implementing an experimental program of avian radar and meteorological monitoring at both the Peñascal and adjacent Baffin Wind Plants on the Gulf Coast of Texas. An evaluation of the radar-driven curtailment program and concurrent fatality monitoring conducted at the two facilities by WEST (Kosciuch et al. 2017) revealed several key findings:

- The number of migrant bird fatalities was consistently low at the two facilities over three years of intensive post-construction fatality monitoring, including during all migration seasons in all years. Of a total of 377 bird fatalities documented, only 109 (28.9%) were nocturnal migrants.
- During three years of fatality monitoring at Peñascal and Baffin, no multi-bird fatality events were documented. The largest number of bird fatalities and largest number of migrant fatalities found on any one search day across three years of survey effort was seven.
- The position of the facilities on the Gulf Coast of Texas did not result in a quantitatively different bird fatality rate when compared to wind energy facilities located further inland within the region. Additionally, the fatality rates at the two facilities were consistent with fatality rates for the adjacent Gulf Wind Project, owned by Pattern Energy (Erickson et al. 2016), which did not institute a radar-driven curtailment program.
- In spite of an absence of radar-triggered automated curtailment during two fallout events (i.e., events where many trans-Gulf avian migrants make landfall concurrently, often due to having flown into inclement weather), few migrant fatalities were found, demonstrating that fallout events without curtailment do not pose high collision risk to migrants.
- Based on curtailment event data, it appears that the threshold conditions defined to minimize collision risk to migrant birds occurred infrequently at the Peñascal and Baffin wind plants.
- Based on these findings, continued application of the radar-driven automated curtailment measure at the Gulf Coast facilities did not appear to be warranted, leading to discontinuation of the automated radar curtailment program at the facilities.

It is important to note that the Peñascal and Baffin sites are located within an important avian migration corridor, as many neotropical migrant passerines winter in South America and breed in North America, crossing the Gulf of Mexico seasonally en route to breeding or wintering grounds. Fountain is not located near or adjacent to a similarly important migration area, nor do any landscape features found within or adjacent to Fountain appear to have characteristics (e.g., coastlines, expansive north-south ridgelines) which might concentrate nocturnal migrants.

Conclusions

Collision mortality of nocturnal migrant birds has generally been low at wind energy facilities, particularly in the western U.S., and multi-bird fatality events are extremely rare. This trend is supported by the results of the three-year fatality study at Hatchet Ridge, located immediately adjacent to Fountain, where small bird fatality rates have been low (0.31 to 2.03 birds/MW/year), suggesting low potential for impacts to nocturnal migrant birds in the region from wind energy development. Relatively large numbers of nocturnal migrant fatalities, such as those found at communication towers, have not been documented at wind energy facilities, likely due to the use of a different type of lighting. Even at facilities within a well-defined migration corridor, such as along the Texas Gulf Coast, migrant fatalities were relatively low and not quantitatively different from facilities further inland in the region. Although nocturnal radar studies at proposed wind energy projects have been implemented as a method to characterize migration patterns and potential exposure levels for nocturnal migrants, no correlation has been found between radar-measured passage rates of avian targets and post-construction fatality rates, indicating that preconstruction radar studies are not an effective tool for assessing risk to migrating birds at wind energy facilities (Tidhar et al. 2012, Stantec 2017). Nocturnal radar studies at Fountain are unlikely to inform risk at Fountain and are unwarranted.

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