The Effects of Noise on Wildlife

Noise standards for wind turbines developed by countries such as Sweden and New Zealand and some specific site level standards implemented in the U.S. focus primarily on sleep disturbance and annoyance to humans. However noise standards do not generally exist for wildlife, except in a few instances where federally listed species may be impacted. Findings from recent research clearly indicate the need to better address noise-wildlife issues. As such, noise impacts to wildlife should clearly be included as a factor in wind turbine siting, construction and operation. Some of the key issues include 1) how wind facilities affect background noise levels; 2) how and what fragmentation, including acoustical fragmentation, occurs especially to species sensitive to habitat fragmentation; 3) comparison of turbine noise levels at lower valley sites – where it may be quieter – to turbines placed on ridge lines above rolling terrain where significant topographic sound shadowing can occur having the potential to significantly elevate sound levels above ambient conditions; and 4) correction and accounting of a 15 decibel (dB) underestimate from daytime wind turbine noise readings used to estimate nighttime turbine noise levels (e.g. van den Berg 2004, J. Barber Colorado State Univ. and National Park Service pers. comm., K. Fristrap National Park Service pers. comm.).

Turbine blades at normal operating speeds can generate significant levels of noise. Based on a propagation model of an industrial-scale 1.5 MW wind turbine at 263 ft hub height, positioned approximately 1,000 ft apart from neighboring turbines, the following decibel levels were determined for peak sound production. At a distance 300 ft from the blades, 45-50 dBA were detected; at 2,000 ft, 40 dBA; and at 1 mi, 30-35 dBA (Kaliski 2009). Declines in densities of woodland and grassland bird species have been shown to occur at noise thresholds between 45 and 48 dB, respectively; while the most sensitive woodland and grassland species showed declines between 35 and 43 dB, respectively. Songbirds specifically appear to be sensitive to very low sound levels equivalent to those in a library reading room (~30 dBA)[1] (Foreman and Alexander 1998). Given this knowledge, it is possible that effects to sensitive species may be occurring at ≥ 1 mile from the center of a wind facility at periods of peak sound production.

Noise does not have to be loud to have negative effects. Very low frequency sounds including infrasound are also being investigated for their possible effects on both humans and wildlife. Wind turbine noise results in a high infrasound component (Salt and Hullar 2010). Infrasound is inaudible to the human ear but this unheard sound can cause human annoyance, sensitivity, disturbance, and disorientation (Renewable Energy World 2010). For birds, bats, and other wildlife, the effects may be more profound. Noise from traffic, wind and operating turbine blades produce low frequency sounds (< 1-2 kHz; Dooling 2002, Lohr et al. 2003). Bird vocalizations are generally within the 2-5 kHz frequency range (Dooling and Popper 2007) and birds hear best between 1-5 kHz (Dooling 2002). Although traffic noise generally falls below the frequency of bird communication and hearing, several studies have documented that traffic noise can have significant negative impacts on bird behavior, communication, and ultimately on

[1] CA Department of Transportation 1998

avian health and survival (e.g., Lohr et al. 2003, Lengagne 2008, Barber et al. 2010). Whether these effects are attributable to infrasound effects or to a combination of other noise factors is not yet fully understood. However, given that wind-generated noise including blade turbine noise produces a fairly persistent, low frequency sound similar to that generated by traffic noise (Lohr et al. 2003: Dooling 2002), it is plausible that wildlife effects from these two sound sources could be similar.

A bird's inability to detect turbine noise at close range may also be problematic. For the average bird in a signal frequency of 1-4 kHz, noise must be 24-30 dB above the ambient noise level in order for a bird to detect it. As noted above, turbine blade and wind noise frequencies generally fall below the optimal hearing frequency of birds. Additionally, by the inverse square law the sound pressure level decreases by 6 dB with every doubling of distance. Therefore, although the sound level of the blade may be significantly above the ambient wind noise level and detectable by birds at the source, as the distance from the source increases and the blade noise level decreases toward the ambient wind noise level, a bird may lose its ability to detect the blade and risk colliding with the moving blade. A bird approaching a moving blade under high wind conditions may be unable to see the blade due to motion smear, and may not hear the blade until it is very close – if it is able to hear it at all (Dooling 2002). Another concern involves the effect of ambient noise on communication distance and an animal's ability to detect calls. For effects to birds, this can mean 1) behavioral and/or physiological effects, 2) damage to hearing from acoustic over-exposure, and 3) masking of communication signals and other biologically relevant sounds (Dooling and Popper 2007). Of the 49 bird species whose behavioral audibility curves and/or physiological recordings have been determined, Dooling and Popper (2007) developed a conceptual model for estimating the masking effects of noise on birds. Based on the distance between birds and the spectrum level, bird communication was predicted to be "at risk" (e.g., at ~ 755 ft distance where noise was 20 dB), "difficult" (.e.g., at ~755 ft where noise was 25 dB) and "impossible" (e.g., at ~755 ft where noise was 30 dB). While clearly there is variation between species and there is no single noise level where one-size-fits-all, this masking effect of turbine blades is of concern and should be considered as part of the cumulative impacts analysis of a wind facility on wildlife. It must be recognized that noise in the frequency region of avian vocalizations will be most effective in masking these vocalizations (Dooling 2007).

Barber et al. (2010) assessed the threats of chronic noise exposure, focusing on grouse communication calls, urban bird calls, and other songbird communications. They determined that while some birds were able to shift their vocalizations to reduce the masking effects of noise, when shifts did not occur or were insignificant, masking could prove detrimental to the health and survival of wildlife (Barber et al. 2010). Although much is still unknown in the real world about the masking effects of noise on wildlife, the results of a physical model analyzing the impacts of transportation noise on the listening area[2] of animals resulted in some significant findings. With a noise increase of just 3 dB – a noise level indentified as "just perceptible to humans" – this increase corresponded to a 50% loss of listening area for wildlife (Barber et al. 2010). Other data suggest noise increases of 3 dB to 10 dB correspond to 30% to

[2] The listening area is the active space of vocalization in which animals search for sounds (Barber et al. 2010).

90% reductions in alerting distances[3] for wildlife, respectively (Barber et al. 2010). Impacts of noise could thus be putting species at risk by impairing signaling and listening capabilities necessary for successful communication and survival.

Swaddle and Page (2007) tested the effects of environmental noise on pair preference selection of Zebra Finches. They noted a significant decrease in females' preference for their pair-bonded males under high environmental noise conditions. Bayne et al. (2008) found that areas near noiseless energy facilities had a total passerine density 1.5 times greater than areas near noise-producing energy facilities. Specifically, White-throated Sparrows, Yellow-rumped Warblers, and Red-eyed Vireos were less dense in noisy areas. Habib et al. (2007) found a significant reduction in Ovenbird pairing success at compressor sites (averaging 77% success) compared to noiseless well pads (92%). Quinn et al. (2006) found that noise increases perceived predation risk in Chaffinches, leading to increased vigilance and reduced food intake rates, a behavior which could over time result in reduced fitness. Francis et al. (2009) showed that noise alone reduced nesting species richness and led to a different composition of avian communities. While they found that noise disturbance ranged from positive to negative, responses were predominately negative.

Schaub et al. (2008) investigated the influence of background noise on the foraging efficiency and foraging success of the greater mouse-eared bat, a model selected because it represents an especially vulnerable group of gleaning bats that rely on their capability to listen for prey rustling sounds to locate food. Their study clearly found that traffic noise, and other sources of intense, broadband noise deterred bats from foraging in areas where these noise were present presumably because these sounds masked relevant sounds or echos the bats use to locate food.

Although there are few studies specifically focused on the noise effects of wind energy facilities on birds, bats and other wildlife, scientific evidence regarding the effects of other noise sources is widely documented. The results show, as documented in various examples above, that varying sources and levels noise can affect both the sending and receiving of important acoustic signaling and sounds. This also can cause behavioral modifications in certain species of birds and bats such as decreased foraging and mating success and overall avoidance of noisy areas. The inaudible frequencies of sound may also have negative impacts to wildlife. Given the mounting evidence regarding the negative impacts of noise – specifically low frequency levels of noise such as those created by wind turbines on birds, bats and other wildlife, it is important to take precautionary measures to ensure that noise impacts at wind facilities are thoroughly investigated prior to development. Noise impacts to wildlife must be considered during the landscape site evaluation and construction processes. As research specific to noise effects from wind turbines further evolves these findings should be utilized to develop technologies and measures to further minimize noise impacts to wildlife.

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[3] The alerting distance is the maximum distance at which a signal can be heard by an animal and is particularly important for detecting threats (Barber et al. 2010).

REFERENCES:

Barber, J.R., K.R. Crooks, and K. Fristrup. 2010. The costs of chronic noise exposure for terrestrial organisms. Trends Ecology and Evolution 25(3): 180–189. Available at: http://www.sciencedirect.com/

Bayne, E.M., L. Habib and S. Boutin. 2008. Impacts of Chronic Anthropogenic Noise from Energy-Sector Activity on Abundance of Songbirds in the Boreal Forest. Conservation Biology 22(5) 1186-1193. Available at: http://oz.biology.ualberta.ca/faculty/stan_boutin/uploads/pdfs/Bayne%20etal%202008%20ConBio.pdf

California Department of Transportation, Technical Noise Supplemental, A Technical Supplement to the Traffic Noise Analysis Protocol, October 1998. Available at: http://www.dot.ca.gov/hq/env/noise/pub/Technical%20Noise%20Supplement.pdf

Dooling, R. 2002. *Avian Hearing and the Avoidance of Wind Turbines*. National Renewable Energy Laboratory, NREL/TP-500-30844. 83 p. Available at: http://www.nrel.gov/wind/pdfs/30844.pdf

Dooling R. J., and A. N. Popper. 2007. The effects of highway noise on birds**.** Report to the California. Department of Transportation, contract 43AO139. California Department of Transportation, Division of Environmental Analysis, Sacramento, California, USA. Available at: http://www.dot.ca.gov/hq/env/bio/files/caltrans_birds_10-7-2007b.pdf

Foreman, Richard T.T. and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecological Systems 29: 207-231. Available at: http://pracownia.org.pl/pliki/roads_and_their_major_ecological_effects.pdf

Francis, C.D., C.P. Ortega and A. Cruz. 2009. Noise Pollution Changes Avian Communities and Species Interactions. Current Biology, in press, doi: 10.1016/j.cub.2009.06.052. Available at: http://www.sciencedirect.com/

Habib, L, E.M. Bayne and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds *Seiurus aurocapilla.* Journal of Applied Ecology 44: 176-184. Available at: http://oz.biology.ualberta.ca/faculty/stan_boutin/ilm/uploads/pdfs/Habib%20etal%202007%20JAE.pdf

Kaliski, K. 2009. Calibrating Sound Propagation Models for Wind Power Projects, State of the Art in Wind Siting Seminar, October. National Wind Coordinating Collaborative.

Lengagne, T. 2008. Traffic noise affects communication behaviour in a breeding anuran, *Hyla arborea.* Biological conservation 141: 2023-2031. Available at: http://www.sciencedirect.com/

Lohr, B., T.F. Wright and R.J. Dooling. 2003. Detection and discrimination of natural calls in masking noise by birds: estimating the active space of a signal. Animal Behavior 65:763-777. Available at: http://biology-web.nmsu.edu/twright/publications/LohretalAnimBehav2003.pdf

Physclips. n.d. UNSW School of Physics, Sydney, Australia. dB: What is a Decibel? Web. 28 January 2011. http://www.animations.physics.unsw.edu.au/jw/dB.htm

Quinn, J.L., M.J. Whittingham, S.J. Butler, and W. Cresswell. 2006. Noise, predation risk compensation and vigilance in the chaffinch Fringilla coelebs. Journal of Avian Biology 37: 601-608**.** Available at: http://www.ncl.ac.uk/biology/assets/MWhitt_pdf/06quinnJAB.PDF

Rabin, L.A., R.G. Coss, D.H. Owings. 2006. The effects of wind turbines on antipredator behavior in California ground squirrels (Spermophilus beecheyi). Biological Conservation 131: 410-420. Available at: http://www.sciencedirect.com/

RenewableEnergyWorld Editors. 2010. Measuring wind turbine noise. Are decibel levels the most important metric for determining impact? Renewable Energy News, November 22. Available at: http://www.renewableenergyworld.com/rea/news/article/2010/11/measuring-wind-turbine-noise

Salt, A.N. and T.E. Hullar. 2010. Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research 268: 12-21. Available at: http://www.sciencedirect.com/

Schaub, A, J. Ostwald and B.M. Siemers. 2008. Foraging bats avoid noise. The Journal of Experimental Biology 211: 3174-3180. Available at: http://jeb.biologists.org/cgi/content/full/211/19/3174

Swaddle, J.P. and L.C. Page. 2007. High levels of environmental noise erode pair preferences in zebra finches: implications for noise pollution. Animal Behaviour 74: 363-368.

Van den Berg, G.P. 2004. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration 277: 955-970. Available at: http://www.nowap.co.uk/docs/windnoise.pdf

Vanderheiden, G. Ph.D. n.d. About Decibels (Db). Web. 28 January 2001. http://trace.wisc.edu/docs/2004-About-dB/