

January 11, 2016

Mr. Paul Williamson
Development Manager
Apex Clean Energy, Inc.
1 Cattail Lane, Scarborough Maine 04074

Dear Paul,

There is no published information on the effect of wind turbines on bees and only one study that I can find on wind turbine effects directly on insects (Long et al. 2010), although several studies suggest that birds and bats are attracted to wind turbines because of insect attraction. The study published by Long et al. (2012) does not explicitly find that bees are at risk, but it does suggest that white and light gray turbines attract insects more than other colors. This corroborates what is known about insect color vision. Insects are trichromatic in their vision like humans, but unlike humans their perceptible wavelengths are shifted toward the ultra-violet range. Bees are highly attracted to UV as flowers tend to reflect heavily in the UV range. This would make turbines that reflect UV appear as giant flowers and attract bees. Thus color paints or surface texturing that minimizes reflection of UV would minimize the attraction to bees. Bees have not been captured in a high percentage relative to other aerial insects when sampled by airplanes or balloons suggesting that bees do not commonly fly at high altitudes, although they are biomechanically capable of flying at high altitudes (only if the air is warm, cold air, common as altitude increases will make it energetically difficult for bees to maintain their internal body temperature).

Bees generally only fly as high as obstacles in their path cause them to. This is because they use the visual pattern of the ground for orientation and so they tend to fly as low to the ground as possible (Barth et al. 2012). This might suggest that wind turbines at the edge of a forest edge might not be an optimal location as bees attempting to cross the forested landscape might fly up to fly over the forest and thus occur at a higher altitude than in the blueberry field. In addition, wind tends to decrease flight efficiency and so to escape these negative effects of wind, bees tend to fly low to the ground.

My own studies involving following and recording honeybee and native wild bees foraging in wild blueberry fields in bloom for almost 10 years suggest that it is uncommon (< 0.1% of flights) for bees after leaving a flower to fly to high altitudes. Occasionally, bees will fly higher in blueberry fields when they are making a direct flight to quickly return to their hive (honeybees) or their nesting sites (native bees) when returning from a long distance. However, this usually does not happen during bloom when flowers are plentiful and they are not foraging far from the hive or nest to find flowers. However, these higher flight altitudes tend to be within 20 meters (60 ft) of the ground. Because the lowest portion of wind turbine blades used with the Downeast Wind Project will be at levels of 50

meters (150 ft) and above, it is unlikely that bees will ever travel in the space of operating wind turbines.

A review of bee flight by Barth et al. (2012) state that bees only fly high above the ground when obstacles are directly in their path of flight (trees, boulders, hills, buildings, etc.). They also mention that bees tend to fly low to the ground because they use ground patterns as cues for orientation and so because of this they tend to fly within visual contact of the ground (a few meters).

In conclusion, based upon my knowledge of bee flight from several years of research, I believe, that bee populations will not be detrimentally affected by wind turbines. In fact, I suspect that car and truck traffic on roads passing through wild blueberry fields will have a much greater impact.

Barth, F., J. A. C. Humphrey, and M. V. Srinivasan. 2012. *Frontiers in Sensing: From Biology to Engineering*. Springer-Verlag Publ., N.Y., N.Y., 186 pp.

Long, C.V., J.A. Flint, and P.A. Leper. 2010. Insect attraction to wind turbines: does colour play a role? *European J. Wildlife Research* 57 (2): 323-331.

Sincerely,



Dr. Frank Drummond
Professor of Insect Ecology