New Ornithological Radar Technologies for Bird & Bat Discrimination & Species Identification

Mr. T. Adam Kelly, MS, Chief Scientist, DeTect, Inc., Panama City, Florida, USA; Mr. Scott McLaughlin, Senior Radar Engineer, DeTect, Inc., Longmont, Colorado, USA; & Mr. Andreas Smith, Senior Radar Ornithologist, DeTect, Inc., Panama City, Florida, USA

Background

The current state-of-the-art technology for bird and bat risk assessment for wind turbine siting studies uses a dual marine radar configuration that scans in both the vertical and horizontal planes simultaneously. Coupled with advanced, automated, computerized signal processing, these Avian Radar Systems provide vastly superior survey data when compared to traditional field methods. These systems generate highly robust datasets that can be used in developing detailed site activity models and mortality risk assessments.

Figure 1: Typical commercially available avian radar system (DeTect MERLIN 1030e Avian Radar System, 2007 model).

With the exception of foraging raptors, the most likely circumstance for birds to collide with a wind turbine is during periods of reduced visibility. Migrating birds generally see and avoid obstacles even in the dark, but if visibility is reduced by fog, low clouds or other weather phenomena, the ability to detect and avoid an obstacle, such as a wind turbine, is greatly reduced. By contrast, studies of bats at turbine sites show that, even in clear nighttime conditions, bats still collide with wind turbines - the reasons for this behavior is not well understood and continues to be studied.

Most current Avian Radar Systems for bird and bat surveys use off-the-shelf or modified commercial marine radars. Some of the more sophisticated systems (such as DeTect's MERLIN™ system, see Figure 1) are capable of automatically detecting, tracking and sizing biological targets into general classes. The current level of the technology does not provide for definitive discrimination of birds from bats nor identify species. This paper reviews how these “bird-bat” and species data gaps can be addressed using a new generation of advanced Avian Radar Systems equipped with a fixed-beam Vertical Profiler Radar (VPR). The more specific data provided by this technology will provide a more complete understanding of mortality risk and aid in developing improved mitigation strategies at wind turbine sites.

Fixed-beam Vertical Profiling Radars

Over the past two years, detailed radar studies using the current generation MERLIN Avian Radar Systems combined with acoustic bat detectors and thermal cameras have identified specific target characteristics of bats and birds within the radar data. Bats in the vertical scanning radar data were clearly identifiable when in steep, diving flights (consistent with foraging flight behavior), patterns which were markedly different from the horizontal flight trajectories of migratory birds (Figure 2). Bats in horizontal flight however could not be conclusively differentiated from birds in the data and the studies concluded that, while some bat activity can be isolated from vertical scanning radar data, a definitive level will require that additional sensors be incorporated.

In addition to the marine radars traditionally used for radar ornithology; tracking radars, (such as air traffic and military radars), have also been used to detect and track biological targets. These systems however

have not been widely used due to their high cost and operational complexity. Tracking radars though are capable of determining the likely type of biological targets (birds, bats, insects) in the radar beam based on the modulation rate of the radar echo resulting from target's wingbeats. If a single bird is tracked in a radar beam for a period of at least several seconds, then the fluctuations in its echo signature provides a means to obtain the wingbeat frequency (Eastwood, 1967). The fluctuations in reflected energy are related to rapid changes in the circumference and volume of the bird's body (Bruderer, 1997) due to the movements of the muscles during powered flight. Generally the peaks in returned power of radar-tracked birds are related to the wingbeat frequency of the target.

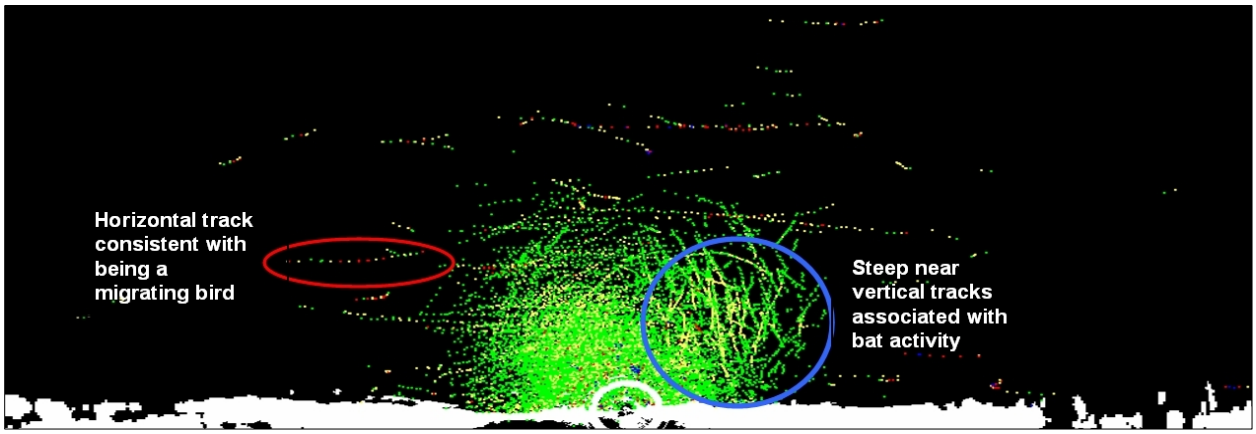

Figure 2: MERLIN Avian Radar TrackPlot of bird and bat tracks.

Wingbeat Frequency

Wingbeat frequencies are measured as the number of flapping cycles per second for a phase of continuous flapping. Many small birds intersperse periods of continuous flapping with periods of gliding. From the smallest insects to the largest birds, wingbeat frequency is proportional to the body mass of the animal. Consequently, the smallest targets (insects) generally have the very highest wingbeat frequencies and the largest (birds) the slowest.

Variability in Wingbeat Frequency

Overall there are well established relationships between wingbeat frequency and the body mass of birds, bats or insects. Skilled birdwatchers have long used observations of small differences in wingbeat frequency and wing stroke patterns to distinguish species at distances too great to see other distinguishing details. A particular bird may vary its wingbeat frequency, depending on whether it is taking off, cruising horizontally, climbing or descending. Within the species however these patterns have a relatively narrow range. Birds of similar mass may also have different wing morphology and therefore have a different wingbeat frequency. Short wings are also easier to flap faster than longer wings. Similarly, wingbeat frequency can be used to distinguish bats from birds when the pattern of wings stroke analysis is applied (Figure 3). These wingbeat characteristics can be measured by radar and used to classify bird and bat targets. When combined with sufficiently ground-truthed algorithms, these data may be used operationally to identify certain species and discriminate birds

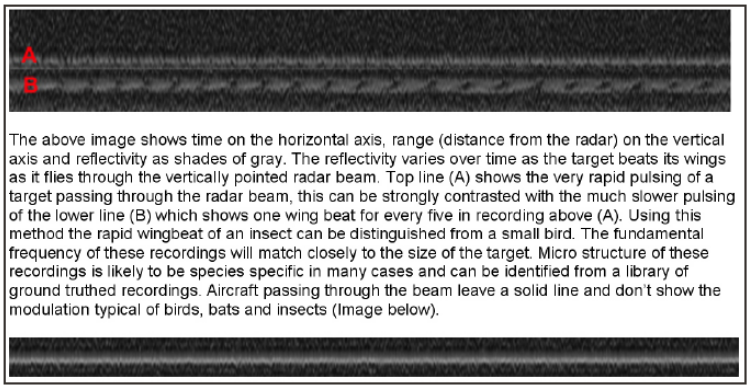

Figure 3: Wingbeat Frequency Radar Data

or bats. Additionally, the very high wingbeat frequencies of most insects in flight can be used to discriminate these targets from birds and bats.

Operational Application of Wingbeat Frequency Data

Based on these principles, DeTect is developing a Fixed Vertical Beam Radar based on relatively low cost and highly reliable components with an operational system projected for commercial availability in 2008. Flying targets passing through the beam will have the wingbeat frequency measured - much like the scanning of a product bar code when passed over the register laser at a supermarket. The beam width will be sufficiently wide to allow even large, slow flapping targets to reside in the beam for several seconds allowing for measurement. This new sensor can be operated independently or in concert with an Avian Radar System to provide specific data on the type of target that has been detected, (i.e. bird, bat or insect).

Figure 4: Prototype MERLIN Fixed-beam Vertical Profiler Radar currently in field testing.

Conclusion

The Fixed Beam Vertical Profiling Radar technology currently under development is scheduled for field deployment testing in the fall of 2007 and will be on the market as the VESPER XVP for operational use in 2008. The technology is a breakthrough in the application of radar ornithology technology for wind farm development and management. With ready access to this technology, libraries of wingbeat signatures can be developed and new mitigation strategies devised that minimize both environmental impacts and economic costs to wind farm operators.

References:

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