May 11, 2021

Re: Avian Radar System – Technical Brief

A robust avian assessment has long-since been a requirement as part of the environmental assessment (EA) for wind power projects in Nova Scotia and other jurisdictions around Canada and the world. Canadian Wildlife Services (CWS), a division of Environment and Climate Change Canada (ECCC) has publisged guidance which prescribes avian assessment techniques and analysis recommendations for the assessment of avifauna as part of the EA of wind power projects. In a response to the industry trend towards larger, more powerful wind turbines, CWS released updated guidance for the EA of large wind turbines (which they define as turbines with a total height in excess of 150m). This updated guidance sites research that indicates that migrating birds travel at a height of between 150m and 600m above the ground, which puts migrating birds at risk of interacting with wind turbines that extend into this corridor, which may result in avian mortalities. It is difficult to assess high altitude migratory bird movements using traditional survey techniques, especially at night when visible observations are not possible. As such, the updated guidance from CWS recommends that avian radar assessments be incorporated into the avian assessment plan for wind power project EA applications as radars have been used as a remote sensing technique for detecting distant bird movements since the 1970s.

The primary objective of the avian radar assessment (ARA) for wind power projects is to quantify the magnitude of high-altitude bird migratory bird movements in the area of a proposed wind power development, and use the data collected to develop a risk assessment model to quantify the level of risk (rate of mortality) that the wind turbines would pose to migrating avifauna. Secondary objectives of ARAs include:

- Using the collected data to identify flight corridors near within or near the proposed study area to inform turbine siting decisions;
- Using the data to characterize avian behaviour in the study area (e.g. identify diurnal movement patterns, correlate movements with weather patterns, etc.); and
- To use the collected data to speciate birds detected (often leveraging data collected through complimentary assessment techniques such as avian acoustic studies and *boots-on-the-ground* surveys conducted by ornithologists.

The focus of this briefing will be to describe the approach that Strum Consulting (Strum) has developed to meet the primary objective of the ARA for wind power projects, which again is to quantify the magnitude of high-altitude migratory bird movements and develop a risk assessment model for that the proposed wind power development poses to migrating birds.

Head Office
Railside, 1355 Bedford Hwy.
Bedford, NS B4A 1C5
t. 902.835.5560 (24/7)
f. 902.835.5574

Antigonish Office
3-A Vincent's Way
Antigonish, NS B2G 2X3
t. 902.863.1465 (24/7)
f. 902.863.1389

Moncton Office
45 Price Street
Moncton, NB E1A 3R1
t. 1.855.770.5560 (24/7)
f. 902.835.5574

St. John's Office
#E120 - 120 Torbay Road
St. John's, NL A1A 2G8
t. 709.738.8478 (24/7)
f. 709.738.8494

www.strum.com info@strum.com

Avian Radar Assessment Approach

<u>Radar Equipment</u>

Strum selected solid state (digital) X-band pulse compression surveillance radars as the basis for our avian radar system (ARS).

Pulse compression radars use advanced signal processing techniques that allow for increased range resolution and higher signal to noise ratios when compared to traditional broadband radar systems. This makes radars equipped with pulse compression technology ideal for use in detecting birds.

Solid state (digital) radars allow for advanced signal processing, which further increases the signal to noise ratio allowing for the detection of small targets at range. Digital radar systems also allow for better integration with radar software, allowing for the application of ground and noise masking filters in real-time. Furthermore, digital radar systems can interface directly with a computer, which allows for the logging and storage of radar data without the need to digitize the analog radar signal, which is required for broadband radar systems. This analog data digitization process often results in the degradation of the radar data and makes detecting birds less likely.

X-band refers to the frequency that the radar transmits. Specifically, the X-band of the electromagnetic spectrum refers to frequencies between 8 and 12 GHz. This is considered a sweet spot for radar systems as the wavelength (between approximately 25mm and 37mm) is sufficiently small to detect small targets with high accuracy and resolution, but at much greater ranges than high frequency radar systems. X-band radars are also effective for detecting targets in a variety of atmospheric conditions, as this frequency range is less subject to distortion from precipitation, fog or clouds than high frequency radars, while still offering good performance in terms of detection range and resolution. X-band radar systems are commonly used for air traffic control systems, missile guidance systems and surveillance radar systems.

The models of radar that are incorporated into our ARS are as follows:

Simrad Halo 6 Pulse Compression Radar
Horizontal beam width - 1.2°
Vertical beam width - 25° (12.5° above and below horizontal axis)
Frequency - 9.4 to 9.5 GHz
Antenna Size - 6 feet (183 cm)

Simrad Halo 20+ Pulse Compression Radar
Horizontal beam width - 4.9°
Vertical beam width - 25° (12.5° above and below horizontal axis)
Frequency - 9.4 to 9.5 GHz
Antenna Size - 18” (45.7 cm)

The radars are integrated into a digital radar server that can control and calibrate the radars, as well as log the data that they collect in digital format. The system is powered by a battery bank charged by solar panels and (when necessary) a micro wind-turbine generator.

Configuration

The Halo 6 radar is oriented horizontally, and is intended to track the movement of birds in the horizontal plain. The Halo 20 radar is oriented vertically, and is configured to track bird movements in the vertical plan, so a height can be assigned to bird-like targets (BLTs).

Performance

We have conducted testing using a radio-controlled aircraft (a drone), as well as surveys conducted by ornithologists collecting visual observations on bird movements in the sweep area of the ARS. These tests revealed that in typical weather conditions, the ARS can reliably detect and track bird movements to a range of approximately 1500m. Larger birds or flocks of birds can be detected at greater ranges. Adverse weather conditions (e.g. rain, snow, or fog) reduce the detection range of the radar.

Data Analysis

The data collected by the ARS is logged to a hard drive, which is routinely replaced so files can be transported for analysis. Files are analyzed using a program developed at Acadia University and the University of Victoria to program radar tracking algorithms for detecting birds, bats, insects and other biological targets. The program is called RadR, and it was released as open source in 2011, and many radar tracking algorithms for detecting and tracking birds have been developed by researchers (and enthusiasts) and published. Strum uses a set of algorithms published by researchers at the University of Victoria, who use a radar system very similar to ours (and on which the design of ours is based). We also have the capability of further refining the algorithms to suit the operating environment of the sites we study (e.g. climatic conditions, seasonal considerations, site specific variables [such as topography, vegetation height, etc.], and the radar control software we use.
The RadR software is used to screen the radar data for BLTs based on a variety of parameters that we manipulate to detect different types of targets (e.g. single target birds vs. flocks of birds, which have different radar signatures). We then analyze the screened data to determine the following variables:

- Movement speed and direction
- Target size
- Altitude (or approximate altitude range)
- Estimated number of birds

This data can then be further screened using a series of parameters to approximate the species. For example, a soaring bald eagle exhibits a distinct behaviour that makes its radar signature unique from a large flock of migrating songbirds, or a flock of Canada Geese. The data is then qualified by these parameters to approximate the species and behaviour of the BLT(s). Behaviours can then be corelated with seasonality and weather patterns. The data can be statistically modeled to approximate the number abundance and character of bird movements to populate a model of how avifauna will interact with the wind turbines. Using published data on turbine-avifauna interactions and mortality rates, the mortality rate of avifauna as a result of the wind-power project under assessment can be estimated. This will help quantify the residual effects of the Project which will aid in regulatory decision making.