Public Service Commission of Wisconsin
& The Statewide Energy Efficiency and Renewables Administration

Environmental and Economic Research and Development Program

Executive Summary
July 2008

A Landscape Scale Decision Support Tool for Monitoring Bird and Bat Migration Across Wisconsin

Prepared by:

Manuel Suarez, US Geological Survey
Patricia Heglund – US Fish and Wildlife Service
Robert Kratt, Media Specialist – US Geological Survey
Eileen Kirsch, U.S. Geological Survey

This report in whole is the property of the State of Wisconsin, Public Service Commission of Wisconsin, and was funded through the FOCUS ON ENERGY program.

focus on energy℠
The power is within you.

Executive Summary

Location: The Upper Mississippi River Region, primarily focusing on stations in Wisconsin but also includes Nexrad stations in Illinois, Iowa, Michigan, and Minnesota.

Objective of research

This project was initiated to begin addressing the uestion, "Are there patterns in timing, location, and direction among migrating landbirds?" that have been at the forefront of discussion with our Federal, State, and County partners with regard to siting wind energy projects. Our goal was to explore the use of Nexrad weather data to see if examining 5 or more years' worth of data would provide us with a sense of the general timing, movement patterns and habitat use by migrating landbirds.

How Nexrad Works

Next-generation Radar, or Nexrad, is the colloquial term for Weather Surveillance Radar-1998 Doppler (WSR-88D), the system of over 150 long-range weather monitoring radars operated by NOAA, the DoD, and the FAA. The primary purpose of the network is to allow meteorologists to forecast significant weather events to protect the people of the United States. However, the radars detect not only meteorological events, but also particulate (e.g. smoke and dust) and biological (e.g. birds, bats, and insects) events as well. The concept of long-range radar biology then, is to identify, observe, and study the biological signals present in the radar data.

A traditional radar system emits radio waves, either continuously or in pulses, and measures the time it takes to receive that energy reflected from a target (e.g. rain drop, bird, etc.). From this, the range to the target can be determined. Doppler radar systems can also measure the radial velocity of a target relative to the station by measuring the

frequency shift of the return signal. Due to the "Doppler Effect", objects moving toward the radar cause an increase in frequency (shorter wavelength or "blue-shift"), while objects moving away from the radar return a lower frequency (longer wavelength or "red-shift").

Why We Chose to Investigate the Use of Nexrad to Study Migration

A strength of the Nexrad system is its nationwide distribution with 154 stations across the United States with many of these stations located in the Midwestern US. Given the broad spatial coverage (for migrating birds, each station has an effective range of about 80 miles from the center of each station) and dense temporal coverage (signals have been collected every 5-10 minutes since the early to mid 1990s), Nexrad provides a unique potential to study avian migration on a regional or national scale.

It is important to note that it is time- and technologically-challenging to amass large amounts of Nexrad data. Each Nexrad station produces hundreds of volume scans per day and the amount of data to sort through and identify biological phenomenon is staggering. We believe there is potential in monitoring migration from a landscape scale and compiling data from multiple years to look for patterns in timing and movements to help communities, managers, and agencies evaluate proposed siting of wind energy projects. We developed this product as a means to more quickly visualize potential patterns in the Nexrad data and also provide supporting data for more in-depth investigation and analysis.

Caveats

There are limitations inherent in using Nexrad, however. First and foremost is that National or Statewide coverage is not complete. Where radar stations do not exist, there will be gaps in our knowledge about bird movements and timing. Nor can a tool developed for landscape scale assessment provide highly detailed information at the

individual site scale. The value in the creation of a landscape scale animation is in its ability to help us hone in on areas that will require more detailed investigation and to look for patterns of timing and movement over time across Wisconsin.

Methods

Examining migration timing, looking for stopover locations, and evidence of possible pathways over multiple years and over any significant amount of space and time is difficult and computationally intensive. The first step is to capture and download the massive amount of data from all the radar stations in Wisconsin and specific sites in the surrounding states. We downloaded approximately a terabyte of data from the National Climate Data Center to create a dataset and visualization tool that could be used by scientists interested in exploring timing and movement patterns as detected by Nexrad. Then we used the data and supporting Flash software to create an animation viewer that would allow a user to visually inspect the data in a number of ways; from a single year and time period, or up to four seasons simultaneously. Six years of Nexrad data were downloaded and used to create animations during the peaks of spring and fall migration (April-May, September-October).

Results/Accomplishments

The animation tool is complete and users can select up to four months (April or May 2002 to 2007 or September or October 2002 to 2007) for concurrent display. Once a particular time frame is selected users can then analyze the raw data for more information with regard to weather patterns, explicit stop over locations, timing of exodus and fall out, etc. For researchers who are interested in conducting additional analyses on the data we recommend that you contact the lead author to obtain the full dataset.

Examples of Interesting Findings

While the scope of this project did not include in-depth analyses of the data, there are a few items that surfaced during the development of the tool and will require further attention. For example, under the 4-year viewer, we have noted lower activity in the Marquette, MI radar station relative to the stations along the Wisconsin border of Lake Michigan. There may be something blocking the radar at the Marquette site, or birds that follow the Lake Michigan shoreline may be taking a different pathway once they arrive at the Upper Peninsula of Michigan. We also observed progressions of movement from south to north in the spring data and from north to south in the fall data and this can be looked at more closely in terms of timing of movements. Lastly, when looking at individual years and months in the single –viewer mode, there are a few locations that repeatedly display high intensity returns, which suggest these might be stop over areas. Further investigation over multiple years and smaller scales is needed to confirm this.

Management Implications

Results from this work can be used in a variety of ways by managers and by researchers who are interested in the timing and patterns of migration events. The animation is a useful visualization of migration across a large landscape but the real value is in the data supporting the animation. We have developed the code necessary to partially automate

the ordering and downloading process and can provide managers and scientists with the code (for those wishing to download data for a different time period or for additional years) as well as up to 6 years of daily Nexrad scenes during peak months for landbird migration.