Every spring and fall, millions of birds and bats participate in one of the largest migrations on Earth. In the spring, they travel from their wintering grounds as far south as Brazil and Argentina to their breeding grounds throughout the United States and Canada. They then return back to their wintering grounds in the fall. Those that travel along the Atlantic or Mississippi flyways (corridors of migrants similar to our highways) encounter a barrier to their movement in the Great Lakes. These are barriers to most birds and bats because they lack safe places to land and require a great deal of energy to cross. Some birds and bats choose to cross the lakes while others travel a much longer distance around the lakes.

The U.S. Fish and Wildlife Service (USFWS) operates two mobile radar units that have been stationed around the shorelines of the Great Lakes each spring and fall since 2011. These radar units track birds and bats as they fly through the air. By combining radar data with current and historical bird surveys, banding data, weather data, NEXRAD radar, and data collected from acoustic and ultrasonic monitors, the USFWS hopes to gather data from all across the Great Lakes and also reduce the biases that any single method of data collection has. With all of this information, the USFWS hopes to gain a better understanding of when migration begins and ends, what environmental conditions affect migration, and when birds and bats may be most at risk from collisions with wind turbines, communication towers, and other man-made objects. All of these factors may change between each year, each migration season, and each location. This project also seeks to determine what areas around the Great Lakes have high concentrations of migrants. This may include stopover habitat where birds and bats refuel and rest before continuing migration as well as areas along the lakeshore that concentrate migrants in the pre-dawn hours.
Avian Radars:
With the exception of hawks, eagles, and waterfowl, the majority of birds and bats travel at night while migrating. This hinders the ability of humans to observe them with their naked eye and requires the use of more sophisticated tools like radar. Two mobile avian radar units have been stationed at 35 locations around all five of the Great Lakes since 2011. The radar units were in operation for both spring and fall migration each year and are often placed within a mile of the lakeshore to evaluate migrant activity over both land and water.

Each radar unit has two antennas for collecting different types of data simultaneously. The horizontal radar looks out 2 nautical miles across the landscape and gathers data on migrant counts and direction of movement. The vertical radar looks directly up into the air and takes a cross section of the airspace to gather data on migrant counts and flight altitude.

Seasonal Patterns:
Our studies reveal that migration occurs in pulses. On most nights during the migration season, migrant numbers build up just after sunset, peak around midnight, and decline before dawn. This pattern happens only on a few nights at the beginning and end of the migration while it occurs almost every night during the height of migration. The numbers of migrants passing through each night is also greatest during the height of migration.
**Daily Patterns:**
The radar units operate 24-hours a day and are able to show the relatively low activity during the day, a buildup of movement around sunset, massive movements at night peaking around midnight, and a decline back to lower activity at dawn. In the graphics below the activity on each radar is shown at two different time periods at the same location. During the 5pm hour there is little movement on either radar and no general direction on the horizontal radar. During the 10pm hour activity is greatly increased to over 10,000 targets per hour and most targets are moving in a southerly direction. Color of a target indicates its direction of movement corresponding to the direction in the same color on the compass rose for the horizontal radar.
**Movement Towards Shore at Dawn:**

During nocturnal migration, birds and bats fly out over the Great Lakes, however, when dawn breaks, they are unable to land on the water and must seek shelter to rest and refuel. When it becomes light enough to see, the birds and bats change their movement direction when they are over the water and come in to land at the closest suitable habitat they can find, often right along the shoreline. Birds and bats over land can continue to migrate for a bit more time and may have more choices for habitat to seek refuge in. In the figure below, you can see the difference in movement direction between 11 PM and 6 AM (Dawn). At 11 PM, there is no difference in movement direction between migrants over the water and those over land. At 6 AM, the migrants over the water are moving eastwards and the migrants over land are moving southwards still. This movement pattern results in migrants being concentrated in the shoreline area and may help inform stopover habitat conservation and development decisions.

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<thead>
<tr>
<th>Horizontal Radar</th>
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<td>11 PM</td>
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<td>6 AM</td>
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**Summary:**

As a result of this project, the USFWS hopes to identify major patterns of migration around the Great Lakes and identify important areas that concentrate migrants. With this wealth of information, the USFWS will be able to formulate guidelines for when and under what environmental conditions wind turbines can operate without risking collisions with migrating birds and bats, as well as provide information for stopover habitat conservation and informing development decisions. As human populations expand and the demand for renewable energy and living space grows, so does the need to make smart decisions that will benefit both people and wildlife. For more information, please go to our website.

[www.fws.gov/radar](http://www.fws.gov/radar)

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