United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

November 25, 2014

Mr. Martin Lagina
Heritage Sustainable Energy
121 East Front Street, Suite 200
Traverse City, Michigan 49684

Dear Mr. Lagina:

Thank you for contacting our office regarding a proposed expansion of wind energy development on the Garden Peninsula as described in your letter dated October 16, 2014, and received in our office on October 20th. The proposed expansion (Attachment #3 to your letter) depicts 21 turbine sites located approximately 4 to 8 miles south of your existing Garden Peninsula wind energy development. You requested our recommendation regarding the proposed project.

Your letter indicates that your desire to expand is based, at least in part, on the post-construction monitoring results at the existing 14 turbine wind energy facility on the Garden Peninsula. We appreciate that Heritage Sustainable Energy LLC (Heritage) incorporated many of our recommendations into the plans for that post-construction monitoring program and look forward to the opportunity to review the full report related to the second year of post-construction monitoring data. However, without a complete report from the second year of monitoring, which describes the associated survey effort, searcher efficiency, and carcass persistence information, no conclusions can be drawn from the summary data provided (your Attachment #2). Limited data from the existing facility alone is not sufficient to allay concerns for a new development in an area that appears to have greater wildlife risks than the currently operating facility.

In order to address your recent request, we have made assumptions concerning what typically can be a complex and lengthy evaluation process [see the tiered approach described in the U.S. Fish and Wildlife Service's "Land-Based Wind Energy Guidelines" (March 2012; "Guidelines")]. We assumed that you are not contemplating any additional pre-construction wildlife studies to gather other site-specific wildlife use information for the locations proposed, and also that you are not proposing to implement operational mitigation (e.g., adjusting cut-in speeds) or making siting changes that might help to reduce the wildlife exposure and risks. Rather you have requested a direct and clear response to what you have proposed.

Based on these assumptions, we recommend that you not site additional wind turbines on the Garden Peninsula for the following reasons:

(1) Many of the turbine sites proposed may be located within bald eagle nesting territories. Our initial review suggests that one active bald eagle nest is located within the project footprint and approximately nine of the turbine sites appear to be within a nesting territory (as represented by half of the mean inter-nest distance, which is the nearest-neighbor distance between two simultaneously occupied bald eagle nests; see Enclosure 1). As a result, we would expect that there would be a high collision risk for bald eagles.

Our office and Heritage have had many discussions concerning the U.S. Fish and Wildlife Service's policy and regulations concerning the Bald and Golden Eagle Protection Act (Eagle Act), including our "Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy Version 2 (April 2013; ECPG). As noted in the Site Categorization process (p. 25 of the ECPG):

> "… projects that have eagle nests within ½ the mean project-area inter-nest distance of the project footprint should be carefully evaluated. If it is likely eagles occupying these territories use or pass through the project footprint, category 1 designation may be appropriate….Projects or alternatives in category 1 should be substantially redesigned to at least meet the category 2 criteria. The Service recommends that project developers not build projects at sites in category 1 because the project would likely not meet the regulatory requirements."

(2) Without operational or siting modifications, wind energy development at the proposed location is likely to represent an elevated risk for northern long-eared bats (*Myotis septentrionalis*), a species currently proposed for listing as endangered under the U.S. Endangered Species Act of 1973, as amended (ESA).

Northern long-eared bats have been commonly detected in Upper Peninsula bat surveys (e.g., 59 % of the bats captured as reported in Gehring and Klatt 2013). However, it is not clear from the post construction monitoring data that you have shared with us for the existing Garden wind energy facility if any fatalities of northern long-eared bats have already been recorded. Regardless, the proposed new location appears to be less than one mile from Fayette Historic State Park, a site where the northern long-eared bat has been documented to occur (Youatt *et. al.* 1983; Michigan State University 1974).

In addition, bat acoustic monitoring completed on the Garden Peninsula suggests high levels of bat use when compared to other sites near the Great Lakes (see Enclosure 2). The post construction monitoring completed in year one at the existing wind energy development on the Garden Peninsula also appears to suggest higher levels of mortality for bats in the genus *Myotis* than at other wind energy developments (e.g., Arnett *et al.* 2008, Kunz *et al.* 2007).

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take is defined as "...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." 16 U.S.C. 1532(19). The terms harass and harm are further defined in our regulations (see 50 CFR 17.3). However, the Service may authorize "incidental take" (take that occurs as a result of an otherwise legal activity), including for non-Federal actions through a permit issued pursuant to section 10 of the ESA (Habitat Conservation Plan).

In the event this species is listed, which could occur as early as April 2015, we would recommend you implement measures that are fully protective of the species or secure a permit to ensure compliance with the ESA for all wind energy developments on the Garden Peninsula. Some of the proposed new turbine locations appear to be very close to forested habitat likely to be occupied by this species from spring through fall. Therefore, turbines located at those sites could require operational modifications (*i.e.*, curtailing operations at specific times/conditions) during that period to avoid killing the species or to meet the ESA's permit issuance criteria that the "applicant will, to the maximum extent practicable, minimize and mitigate the impacts of the taking" (section 10(a)(2)(B)(ii)).

(3) The avian monitoring conducted on behalf of Heritage documented high levels of avian use throughout the peninsula; most, if not all, of which were species protected by the Migratory Bird Treaty Act. As characterized in one report, "Significant bird migration occurs on the Garden Peninsula" (Kerlinger and Guarnaccia 2007, p. 34). At a minimum, this level of avian use represents high exposure and potential for collision mortalities from wind energy development. For example:

- In 1 hour on September 10, 2007, "... a large number of landbirds (over 500, mostly warblers) were observed... some flying at treetop level, but many were flying higher up." Also from 2007 observations, "Raptors, both migrating and foraging, were quite numerous ["nine species recorded, about 450 individuals recorded in three days"] (Kerlinger and Guarnaccia 2007 p. 16; Guarnaccia and Kerlinger (2008) p. 30);
- In 92 hours of observation in the spring 2008 "A total of 4,205 birds were observed...of which 19.7% (547) were raptors, 62.2 % (800) were landbirds, and 18.1% (261) were waterbirds" (Guarnaccia and Kerlinger 2008 p. 13);
- In the spring of 2010, "During the 32 large bird surveys, observers detected 1,748 large birds of 21 species. There was a mean of 54.6 birds detected per survey (19.9 birds / hour)" (Gehring 2010, p. 11); and
- In the fall of 2010, "During the 20 large bird surveys, observers detected 14,656 large birds (600 total birds when all raptors and Common Ravens are tallied) of 15 species (12 and 13 species at sites 1 and 2, respectively). There was a mean of 732.8 birds detected per survey (122.1 birds / hour)" (Gehring 2011 p. 14).

(4) Other landscape factors that suggest this site may pose a greater risk to wildlife than other sites include:

   (a) <u>Proximity to High Priority Conservation Areas</u>–It appears that all of the proposed turbine locations are within two miles of a Great Lakes shoreline and many of the southernmost sites appear to be within one mile of the shoreline. Because of the importance of coastal areas for bird migration and breeding habitats, we consider wind development within three miles of a Great Lakes shoreline as likely to be a higher risk for mortalities of species protected by the Migratory Bird Treaty Act. Please see Enclosure 2 for additional information on avian use on the Garden Peninsula based on the Service's Great Lakes radar monitoring project.

The Garden Peninsula is on the east side of Big Bay de Noc. In or adjacent to Big Bay de Noc are four Important Bird Areas (National Audubon Society). Also the proposed plan would site turbines close to and in some cases directly between the protected forested lands of Fayette Historic State Park and the Lake Superior State Forest. Birds and bats may regularly move between these forest blocks. Given the proximity to State Forest and Sate Park lands, we would also encourage you to coordinate closely with the Michigan Department of Natural Resources on this proposed expansion.

The Nature Conservancy's Great Lakes Migratory Bird Stopover Portal (http://glmigratorybirds.org), suggests that the forested lands of the State Park and State Forest are very important for migratory birds and includes them in the highest priority category and noting in general:

> "Our analysis suggests that areas close to the Great Lakes shorelines are important stopover sites for all groups of birds, including landbirds, shorebirds and waterfowl. Landbirds are most concentrated within a few miles of the shoreline, migrating waterfowl are most common in nearshore shallow waters of the Great Lakes, and a number of shorebirds use Great Lakes shorelines disproportionately to other habitats. For all bird groups, relatively extensive areas of habitat seem to be used more than smaller areas of habitat except for landbirds where small areas of habitat surrounded by development harbor high densities of birds."

(b) Peninsular Land Form – As part of a long and narrow peninsula within the Great Lakes, birds in migration are likely to use these areas as "fall-out" or staging areas as the first or last land encountered as they navigate over or around the waters of Lake Michigan. In addition, as noted previously in survey work for the Garden Peninsula (Kerlinger and Guarnaccia 2007, p. 16) birds in migration may descend down and then immediately return back up a peninsula. In that study, large numbers of birds ["…most of the migrant raptors (and also many hundreds of Blue Jays…"] were observed to turn around upon reaching the end of the Garden Peninsula and then "follow the western side of the peninsula" north. This represents a potential increased exposure risks for wind developments sited on a peninsula when compared to other inland locations where birds exhibit a more linear migration pattern.

(c) Topographic Variation – It appears that the southernmost proposed turbine sites are located on a higher bluff area. One factor that has been identified as contributing to increased risk for fatalities is topography that modifies avian

> flight behavior (Hoover and Morrison 2005; Katzner *et. al*. 2012). For example, areas where wind uplifts influence raptor behavior could in turn increase exposure for turbine collisions at those sites. Avian surveys on the Garden Peninsula (Guarnaccia and Kerlinger 2008, p. 20) noted "some raptors at Burnt Bluff did not follow the peninsula north. Rather, they used the thermal lift generated over the bluff to gain height, which they then used to cross Big Bay de Noc."

The Service's Guidelines offer a tiered approach for evaluating a proposed wind energy development. Developers decide whether and how to proceed, but as Heritage's consultants stated: "There are two situations where turbine placements on the Garden Peninsula may result in higher collision risk than what has been documented elsewhere. These situations are: 1) turbines placed near lakeshore woodland patches used by nocturnal-migrant songbirds during fallout events, and 2) turbines placed on lakeshore bluffs where listed raptors use updrafts" (Kerlinger and Guarnaccia 2007, p. 5). This latest proposal seems to exemplify both situations and warrants careful evaluation.

In summary, our Guidelines note that "Early consultation offers the greatest opportunity for avoiding areas where development is precluded or where wildlife impacts are likely to be high and difficult or costly to remedy or mitigate at a later stage." We believe that the information available currently suggests that from a wildlife perspective the development as proposed should be avoided.

Our office has invested a significant amount of time and effort in working with Heritage related to potential wildlife impacts from wind energy development on the Garden Peninsula. We continue to encourage Heritage to apply for a permit pursuant to the Eagle Act for your existing wind energy development and to implement measures that are fully protective or secure an ESA permit, should the northern long-eared bat be listed.

Thank you for the opportunity to review the proposed development. If you have questions concerning our assessment, please contact me at 517-351-6274 or scott_hicks@fws.gov.

Sincerely,

Scott Hicks

Scott Hicks
Field Supervisor

Enclosures (2)

cc: USFWS, P. Beiriger (e-mail)
MDNR (2), K. Cleveland and R. Fahlsing (e-mail)

References

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Michigan State University, Mammal Research Department Record: 51 *Myotis keenii keenii* (42 females, 9 males), collected 17 - 18 July or August 1974 at Fayette State Park, T38N, R19W, S4, Delta County, MI. Specimens F1- F51, Object IDs: MR. 23368-23418. (note for a clarification on taxonomy see Kurta (2007): "… recommend all specimens east of the Rockies be called *Myotis septentrionalis*. References to *Myotis keenii* … for the Great Lakes region simply refers to specimens collected prior to 1979, or reflect a conservative taxonomic opinion."

National Audubon Society, Important Bird Areas. Website: http://netapp.audubon.org/iba#, accessed November 21, 2014; (note: IBA sites in or adjacent to Big Bay de Noc: Round Island, Snake Island, St. Vital Island, and Ogantz Bay Marshes)

The Nature Conservancy, Great Lakes Migratory Bird Stopover Portal, Web site: http://glmigratorybirds.org; accessed November 21, 2014. (note: the highest priority category for Landbird Model Score=5)

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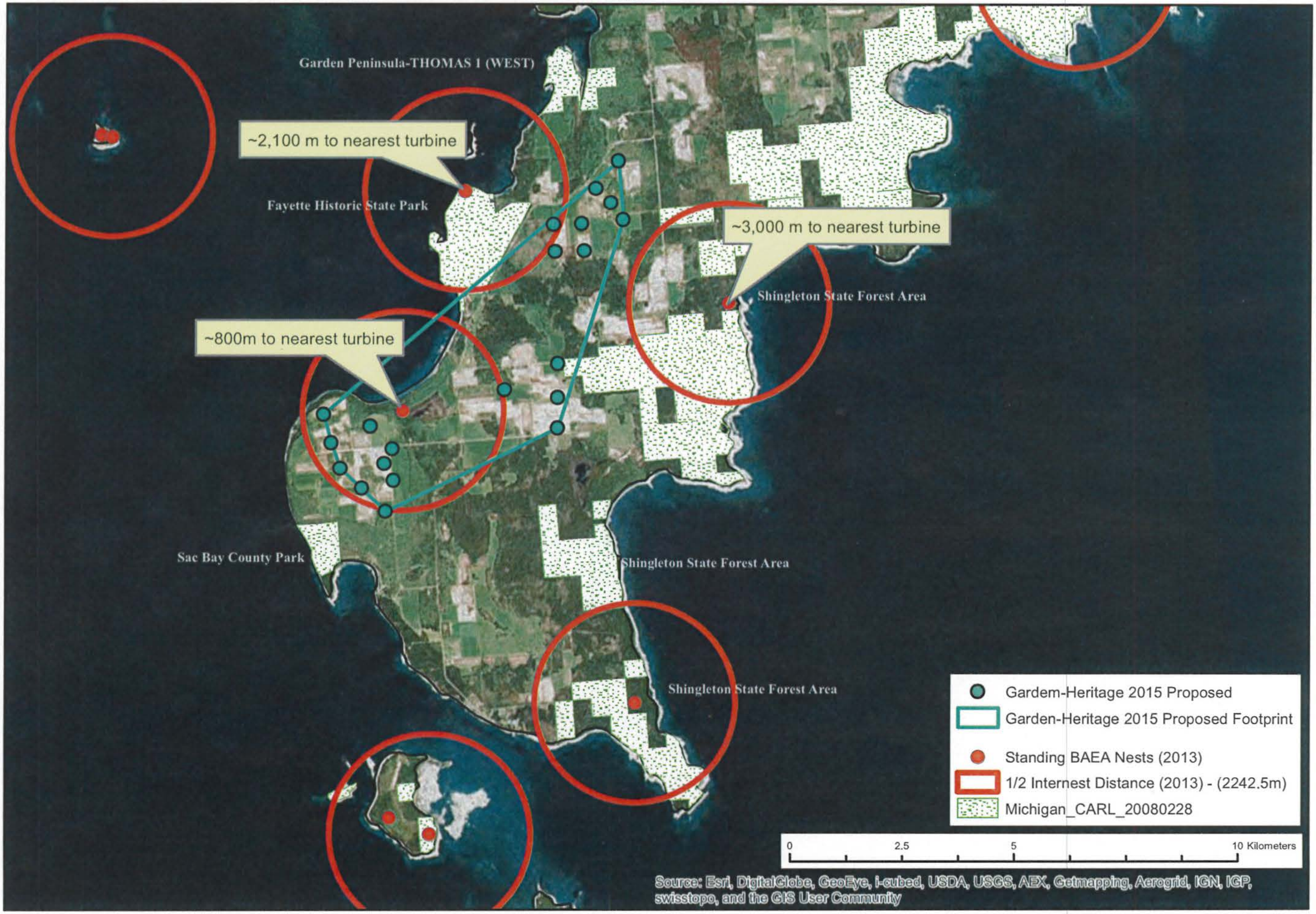
ENCLOSURE 1

Heritage Wind - Garden 2015 proposal
Known standing BAEA nests (2013)

November 3, 2014
Do Not Distribute



Summary of Initial Findings of Nocturnal Migration on the Garden Peninsula, Delta County, Michigan

Provided by
U.S. Fish and Wildlife Service
Region 3, Division of Ecological Services
Avian Radar Team
November, 2014

Key Points

- Millions of birds and bats use the Great Lakes region throughout the spring and fall migration season.
- The shorelines of the Great Lakes may be particularly valuable to these animals due to habitat and as a resting area before or after lake crossing and as refuge at dawn.
- The USFWS currently recommends a 3 mile buffer zone from the Great Lakes shoreline, however inland wind facilities can also pose a risk to birds and bats.
- In considering installation of additional wind turbines , important items related to wildlife impacts include: distance from Great Lakes shore, distance to habitat, and height of infrastructure (e.g. wind turbine, tower, building, etc.).

Each spring and fall, millions of birds and bats pass through the Great Lakes region during their migration. In the spring, hundreds of species of birds fly from their winter grounds in the Caribbean and Central and South America to their breeding grounds in the United States and Canada. These birds, along with their offspring, return to their wintering grounds each fall. While much less is known about bat migration, we know that bats in the Great Lakes region exhibit two different migration patterns. Regional migrant bats (cave bats that winter in the Great Lakes region) move through the area to and from their hibernacula. In addition to these regional migrants, there are three species of tree bats that undertake longer migrations each spring and fall, moving between their winter habitat in the southern U.S. and Mexico to their summer habitat in the northern U.S. and Canada.

Migrating birds and bats often follow migration corridors. Migration corridors are not well understood, though areas near the Great Lakes coastlines are reported to host concentrated movements of these flying animals during the migration seasons. The Great Lakes likely act as ecological barriers to migrating birds and bats that cannot land on water and can require substantial energy to cross; thus migration movement becomes concentrated along the coastlines. Peninsulas, such as the Garden Peninsula in Delta County, may be particularly important for these migrants. As the need for renewable energy and living space increases, so does fragmentation of habitat and airspace within migration corridors.

For the past four years, the U.S. Fish and Wildlife Service's Division of Ecological Services has been studying nocturnal migration of birds and bats along the Great Lakes shoreline using a combination of avian radar and acoustic monitors. We have had two radar sites in Delta County, MI. Our Technical reports are not yet completed for any of these sites, but we have attached an overview of pertinent points from our findings for your consideration. We have tried to keep this brief out of respect for your time, but would be happy to address any questions you or your staff may have. Information regarding our studies is also available on our website at: www.fws.gov/radar .

Bat Activity

Two sites on the Garden Peninsula were sampled using ultra-sonic monitors for the presence of bats during both the spring and fall migration period as well as the summer (resident) time period in 2012. Both data sets were run through two automated species identification programs. Outputs were checked for consistency of species presence during the three seasons (spring, summer, and fall). Seasonal presence was visually verified through review of sonograms by Service staff. All six anticipated species were represented in the data: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown bat (*Myotis lucifugus*), and northern long-eared bat (*Myotis septentrionalis*).

The Garden1 site was located northwest of Carboneau Point (Lake Superior State Forest, Shingleton Management Unit) on the east side of the Garden Peninsula. This site is in a patchy forested area with natural and man-made openings (low lying wet areas, road cuts, picnic and camping areas, etc.). Understory is open both under the canopy and where canopy openings exist. Continuous forest is adjacent to the site. Lake Michigan is less than 0.5 miles from the site.

The Garden2 site was located within Fayette Historic State Park. This site is in a regenerating upland field landscape that is managed for successional growth of woody shrubs and small trees that rarely exceed 3 meters in height. Large grass "pathways" separate pockets of woody plants. Continual forest and maintained fields are directly adjacent to this site. This site is less than 1 mile from Big Bay De Noc.

Both sites had very high numbers of Myotid bats and with both species (little brown and northern long-eared) being present during spring, summer, and fall. Both species were detected at higher numbers on the west side of the peninsula though the variation in numbers of northern long-eared is minimal (n=922 vs. n=718, number of passes respectively) compared with little brown (n=9077 vs. n=2919, respectively). Eastern red bats and silver-haired bats were also present in all three seasons with considerably higher numbers on the western side of the peninsula than on the more heavily forested east side. Hoary bats, though very low in numbers, seem to have a similar landscape use as eastern red bats and silver-haired bats, preferring the western side of the peninsula though it too was present at both sites. Big brown bat is a resident bat on the peninsula in that it is likely the only bat that does not migrate some distance to find suitable winter habitat.

In general, bat activity around the Great Lakes is higher than most other locations studied in the middle U.S. (poster by K. Heist at NWCC Research X meeting, December 2014). Garden1 had fairly high bat activity for the Great Lakes, but lower than Door County, WI sites. It is likely that substantial numbers of migrants travel between Door County and Garden peninsula's during spring and fall migration.

Radar Studies

The US Fish and Wildlife Service (USFWS) has also been studying migration patterns near the Great Lakes shorelines using two avian radar units. These avian radar units collect data from tracked targets as they pass through the airspace (Figure 1). Currently, we cannot differentiate a bird from a bat in our radar data; therefore, we refer to collected data as "targets." These units operate in horizontal and vertical mode simultaneously, and continuously collect data 24 hours a day unless shut down due to maintenance or malfunction. The horizontal scanning radar (HSR) records data from targets flying across the landscape, and provides information on direction of travel and location of targets. The vertical scanning radar (VSR) provides information on target heights and we use the VSR data for obtaining count estimates.

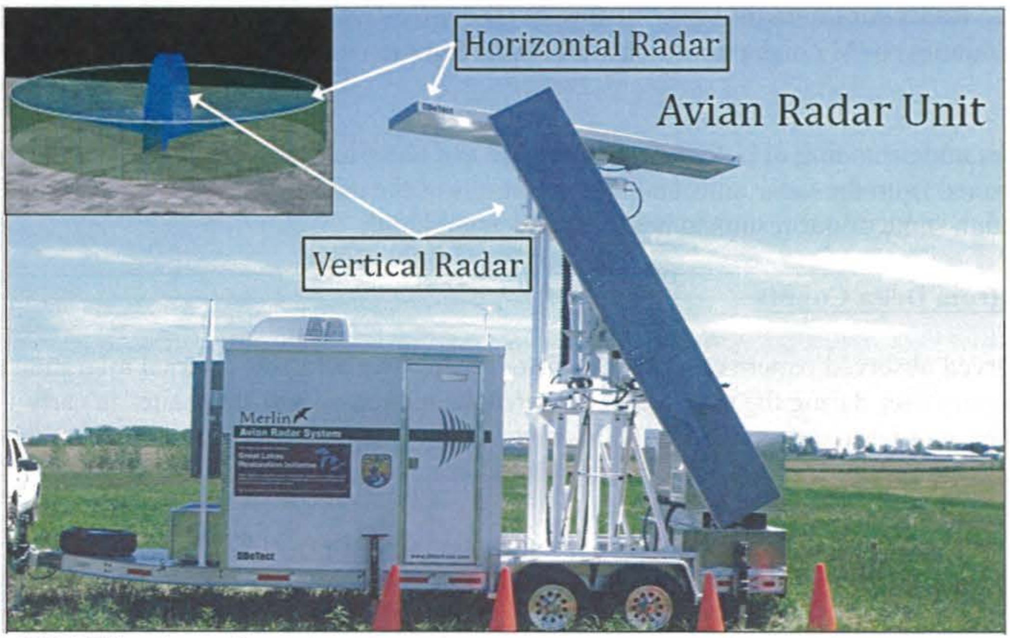


Figure 1. USFWS avian radar unit.

We established study sites at two locations in Delta County, Michigan during the early part of the fall 2012 migration seasons (August 9 – September 1, 2012), one on the west side of Green Bay, south of Escanaba, and one on the Garden Peninsula, near Garden (Figure 2). On September 1 we moved the radar units to two sites in the lower peninsula of Michigan, on the east and west sides of Saginaw Bay, where we stayed the remainder of the migration season (September 2 – November 7, 2014).

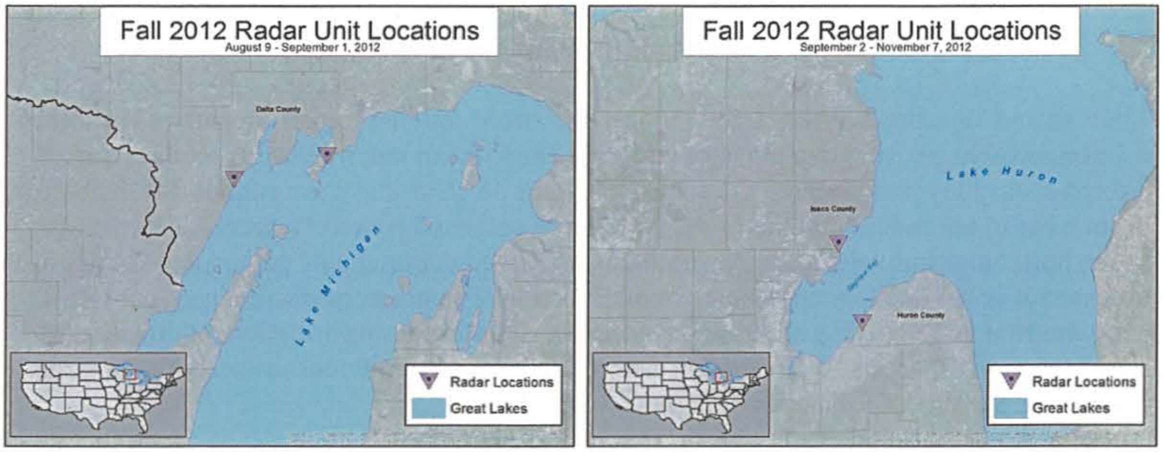


Figure 2. Radar sites in in the upper peninsula (Delta County) and lower peninsula (Iosco and Huron Counties) of Michigan during the fall 2012 migration season.

It requires understanding of both the radar outputs and radar limitations to be able to interpret the data obtained from the radar units and the limitations of the data. We will try to briefly guide you through some of our results to help you understand both.

Results from Delta County

We observed observed patterns that are consistent with concentrated nocturnal migration at both Delta County sites during the time we were there. We moved to new study sites in early September in order to document migration at additional locations. However, based upon our findings at the subsequent two sites in Iosco and Huron Counties, we missed the peak of migration while we were in Delta County.

The images in Figure 3, called trackplots, show tracked targets recorded in a one hour time period from our site on the Garden Peninsula. Figures on the left are from the horizontal radar and show direction of movement across the landscape; the colored compass at the top of the image indicates direction of travel (i.e. blue = north, red = south). The figures on the right are from the vertical radar and show altitudes at which targets are flying. The top two images, August 28 at midnight, are from a night when target count was high. Notice the uniformity of direction toward the south on the HSR and the large numbers of targets on the VSR. The lower pair of images are from August 29 at the noon hour. Notice the low numbers observed and the lack of uniformity of direction. Many of the daytime tracks are from local movement which is typically non-directional, with possibly a low number of daytime migrants included.

One of the ways that we define migration for radar data is uniformity of directional movement. Typically this would be southward in the fall and northward in the spring. However, we occasionally also observe “reverse migration” (movement opposite of the anticipated direction) and also movement perpendicular to the anticipated direction. During the time that we were on Garden Peninsula we observed a fair amount of reverse and perpendicular migration. A second component of migration is high target passage rate at night as compared to other times. A third component of nocturnal migration is that passage rate tends to increase toward midnight and then decrease toward dawn.

<table>
<tr><td>Horizontal Scanning Radar</td><td>Vertical Scanning Radar</td></tr>
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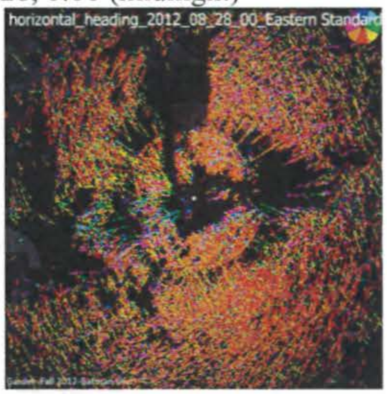
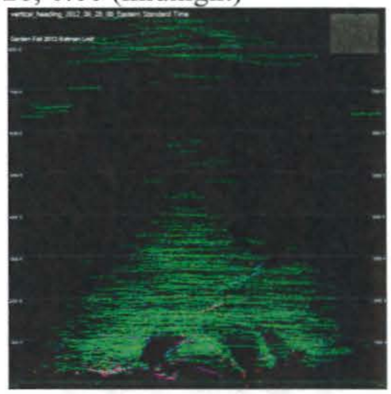
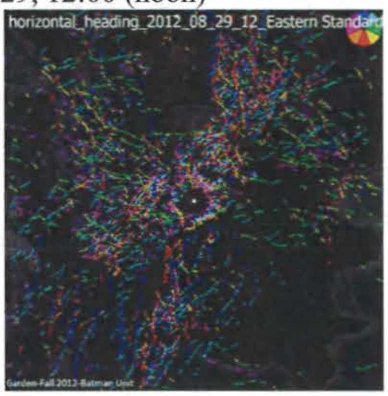
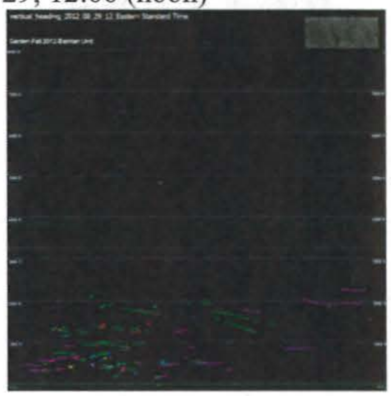
</td><td>August 28, 0:00 (midnight)
</td></tr>
<tr><td>August 29, 12:00 (noon)
</td><td>August 29, 12:00 (noon)
</td></tr>
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Figure 3. Trackplots from a radar site on the Garden Peninsula in Delta County, fall 2012 from the HSR (left column) and VSR (right column) antennas depicting heavy migration (moving in a southerly direction) at midnight (top row) and low numbers of local traffic (moving in random directions) at noon (bottom row).

Figure 4 shows the pattern of increasing migration beginning at dusk, peaking near midnight, decreasing toward dawn, and then being relatively low during the day for our two sites in Delta County, Michigan. Notice that these sites show relatively similar nocturnal passage rates with high levels of nocturnal activity. High levels of nocturnal passage rates will be shown in subsequent figures as well.

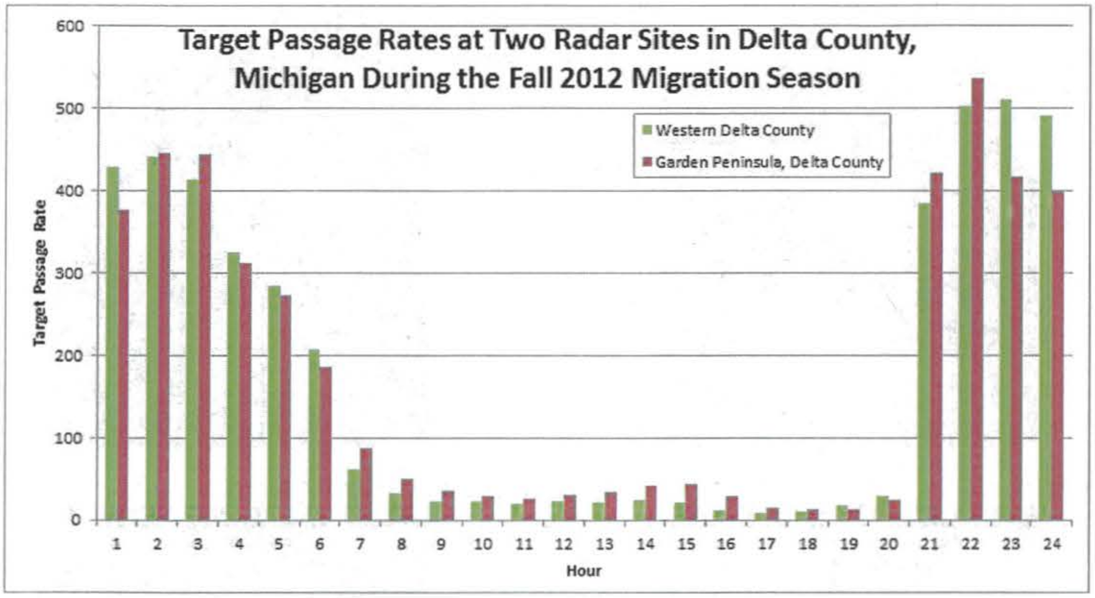

Figure 4. Hourly mean target passage rate for two sites in Delta County, Michigan.

Figure 5 shows the timeline of migration activity at our study site on the Garden Peninsula in Delta County. It is easiest to see the change in activity by looking at the counts from the vertical radar (red line). Notice the fluctuation in hourly target counts both by time of day and throughout the season, with lower counts in early August and numbers peaking later in the month, as we move into the busiest part of migration season. On September 1, we changed study sites, moving to the lower peninsula of Michigan and stayed there for the remainder of migration season (through November). Migration was strong at these sites, with target counts tapering off by the end of October (Figure 6). Based on our experience conducting radar surveys at locations near the shorelines of the Great Lakes for the past 3 years, we expect that migration continued to occur in Delta County through the end of October as well. Migration probably peaked in mid to late September based upon our surveys in Iosco and Huron Counties during this time period (Figure 6).

Peaks for both the horizontal (HSR) radar (blue line) and the vertical (VSR) radar (red line) typically occur within several hours of midnight. Note that nocturnal migration is pulsed, occurring on some nights and not on others. This is a consistent pattern at all the sites we have monitored. The low points between peaks are typically during daytime. These graphs reinforce what we saw in Figure 4, with peaks of migration near midnight, and high target counts during migration events compared to both daytime numbers and nights with little or no migration. The uniformity of direction can be observed in the trackplots shown in Figure 3 or summarized in "rose" graphs that provide direction of travel over a time period. This type of migration pattern is typical to what we have seen at other sites along the shorelines of the Great Lakes.

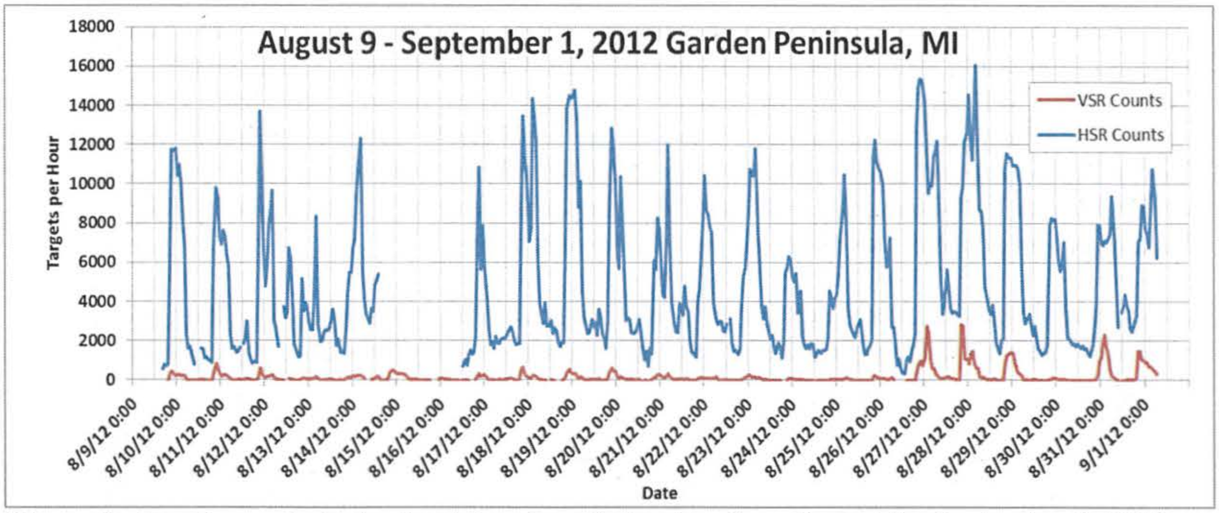

Figure 5. Hourly counts by horizontal and vertical radars from August 9 – September 1, 2012 on the Garden Peninsula, Delta County, Michigan. Light gray vertical lines represent midnight.

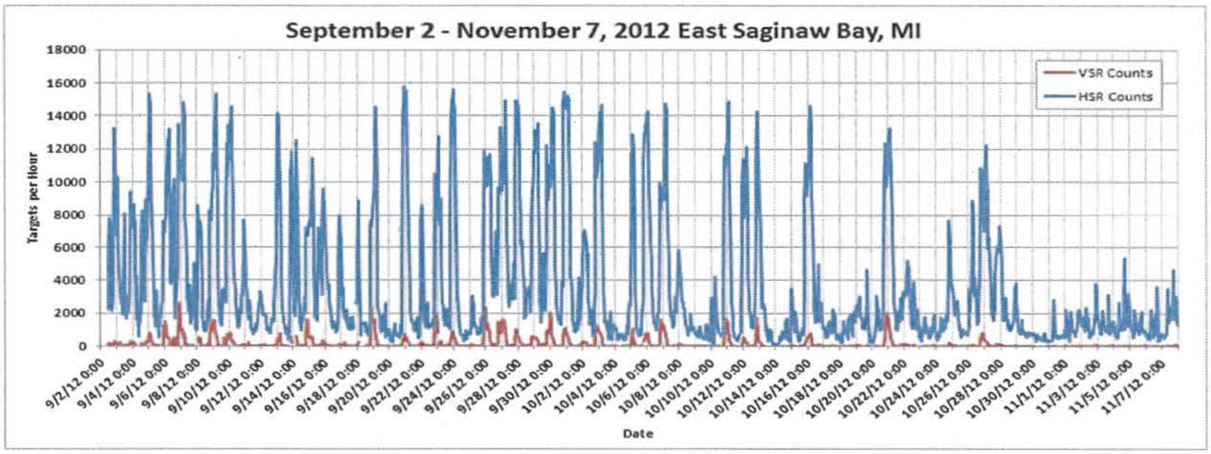

Figure 6. Hourly counts by horizontal and vertical radars from September 1 – November 7, 2012 on the west side of Saginaw Bay, Huron County, Michigan. Light gray vertical lines represent midnight.

In addition to observing heavy concentrations of migrants along the shoreline, this area is vital to migrants in more subtle ways. We consistently observe nocturnal migrants flying offshore but parallel to the shoreline. Depending upon location and weather conditions, we sometimes observe migrants crossing the open water from one shore to the other. Targets crossing the Garden Peninsula were shown flying south towards Door Peninsula, as well as west towards Stonington Peninsula and east towards Beaver Island.

The rose graphs in Figure 7 help to demonstrate the difference in activity during the four biological periods of dawn, day, dusk, and night for the site in the Garden Peninsula. The shape of the colored portion of the graph indicates direction of travel, with a near circular shape indicating that targets were traveling equally in all directions, as is usually the case for the day period. The rose graphs sort the direction of travel into only eight potential bins so actual direction of travel cannot be determined finer than that. At the Garden Peninsula however, travel orientation during the day slightly favored the southwest, suggesting the presence of daytime migrants or possibly local waterbirds, flying roughly along the peninsula and possibly toward Door County, WI and the islands in between. For dawn, again travel was oriented toward the southwest. During nocturnal migration, targets are consistently observed migrating through the Garden Peninsula, and either crossing Lake Michigan with slightly more targets heading southwest over the island chain in Green Bay compared to southeast over Lake Michigan. At dusk, direction of travel was relatively equal in all directions.

We suspect migration routes are similar in the spring, with migrants arriving at the Garden Peninsula after crossing Green Bay or Lake Michigan or coming from Door County Peninsula in Wisconsin. In all cases, migrants flying over open water need to have a safe landing option as dawn approaches and they seek the nearest land for rest and refueling. However, as dawn approaches, the typical nocturnal migrants consisting of passerines (songbirds) and bats have to reach land in order to roost and we have observed this movement to shore at dawn at many of our radar sites. Neither group normally migrates during the day so we often observe movement to shore at dawn of targets over water. This is one of the reasons that the near-shore area is critical to migrants, because it serves as the first safe stopover habitat as migrants flying inland off the lake come in to rest at dawn and as the last refuge as they arrive at a lakeshore after a long night of migrating. Notice on each graph that the octagonal lines represent mean number of targets per hour per *biological period*, thus numbers are higher for the day and night time periods since they are much longer in length than the dawn and dusk periods (11 hours compared to 1 hour).

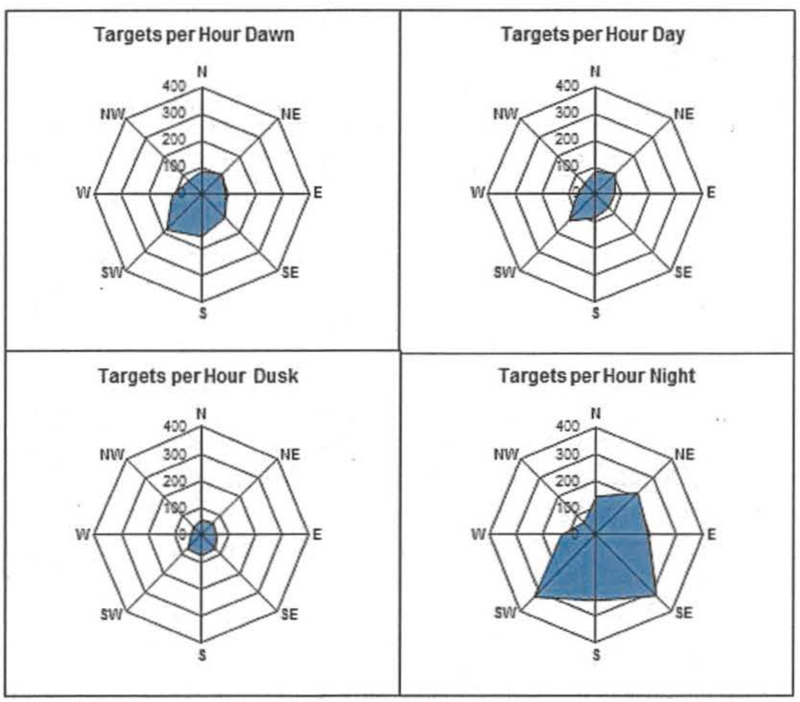

Figure 7. Directional rose graphs for the Garden Peninsula in Delta County, fall 2012 showing the mean number of targets observed per hour per biological period and directions of travel.

The dawn time period likely shows higher counts than dusk since migrants still in flight are forced to come to land as dawn approaches, while dusk can be the time period that many migrants resume migration flights although it can begin an hour or so later. Figure 4 provides a better impression of the mean number of targets per hour over the 24 hour period.

Figure 8 contains a set of trackplot graphs from the southwest Delta County site depicting travel at 0300 hours where targets were traveling in a south to southeast direction and by 0700 hours targets over water had changed direction to travel strongly to the west toward land while the targets over land were still moving in a more southwestern direction. We observe this travel to shore at dawn, both on the rose graphs and trackplots, at all of the sites.

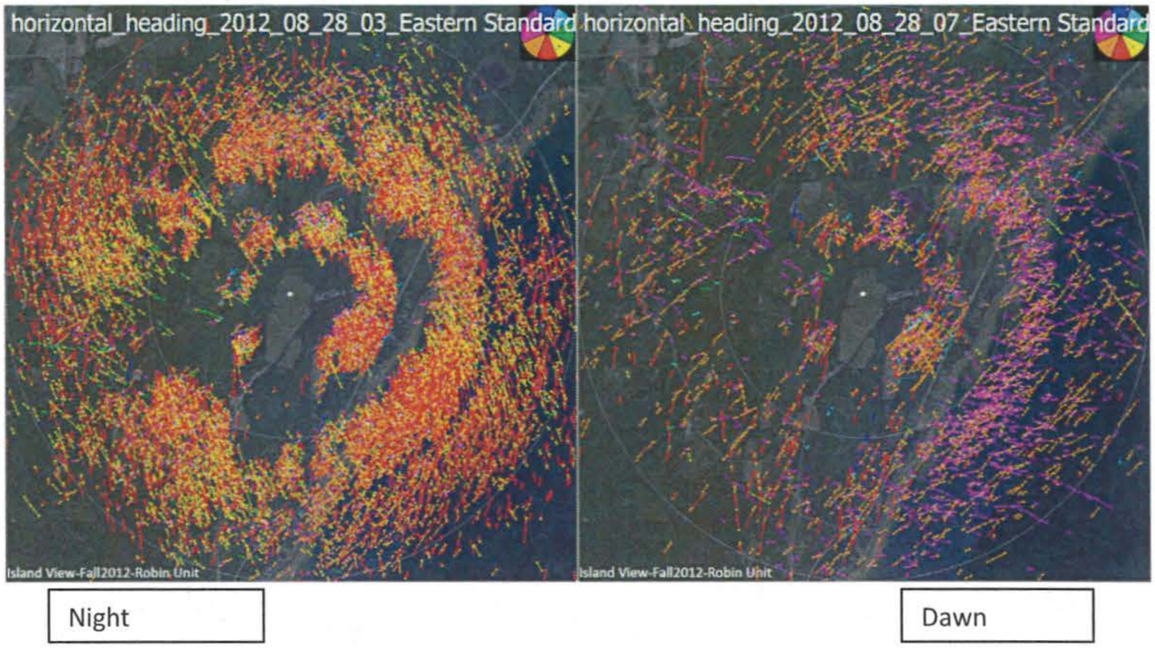

Figure 8. Horizontal (HSR) trackplots from Southwest Delta County at 0300 hours (left) and at 0700 hours (right).

Interpreting Radar Data

When other avian radar studies are conducted, data is sometimes presented in a manner that we believe can be misleading, particularly to the relatively uninformed reader. We want to briefly address some of these concerns to help you be better informed and understand how improper parameters can lead to false conclusions. Often radar studies will conclude that the site sampled has high numbers of migrants passing through but that it isn't of concern because the vast majority of migrants are found at altitudes far above the rotor-swept zone (RSZ).

Figure 9 is also from our study site on the Garden Peninsula in Delta County and shows the variation in flight altitudes used by birds and bats (local birds and bats as well as migrants) throughout our survey period, based on target density. The dashed black line represents a peak RSZ of 150 m. The dark blue line represents nocturnal mean target height, while the light blue line represents nocturnal median target height. Because the vertical radar antenna samples an ever increasing width of area as it travels from the radar unit, we have developed software that converts the raw number of targets observed per altitude band to density of targets observed adjusted for volume sampled. The color of each rectangle indicated the relative density observed for that altitude and time as indicated by the key on the right. Labels represent the max value of the altitude bin.

This graphic shows the altitude bands where we had the most detection, 0 – 1,200 m. A technical deficiency with our radar reduced our ability to detect targets between 1,200 and 2,100 m, however we had some detection within this range and up to 2750 m throughout the season. This graphic demonstrates that night hours at our site on the Garden Peninsula show relatively heavy flight activity between the dates of the study (August 9 – September 1, 2012). Many targets are flying well within the rotor swept zone of a turbine through the sample period, with heaviest activity during the night hours. Range of flight altitude increases during the nighttime hours, however a high degree of targets are within, or just above or below, the RSZ and are at risk. This graphic also shows that mean and median flight altitudes do not reflect peak density and thus misrepresent true flight risk. With any radar study, lack of detection can occur at low altitudes due to ground clutter and with distance from the radar unit due to signal attenuation; these factors warrant consideration. Our target density estimates are an attempt to reduce this inherent bias against low-flying targets.

Studies that report mean and median target heights rather than providing a graph showing altitudes where targets were observed should be questioned because mean and median are skewed upward as a result of high flying targets. This can be demonstrated by the following example:

> If one hundred targets are observed and 80 of the targets are flying at 100 m and 20 targets are flying at 1,000 m, the mean altitude of the group is 280 m which is well above the RSZ (rotor-swept zone) although 80% of the targets were flying in the middle of the RSZ.

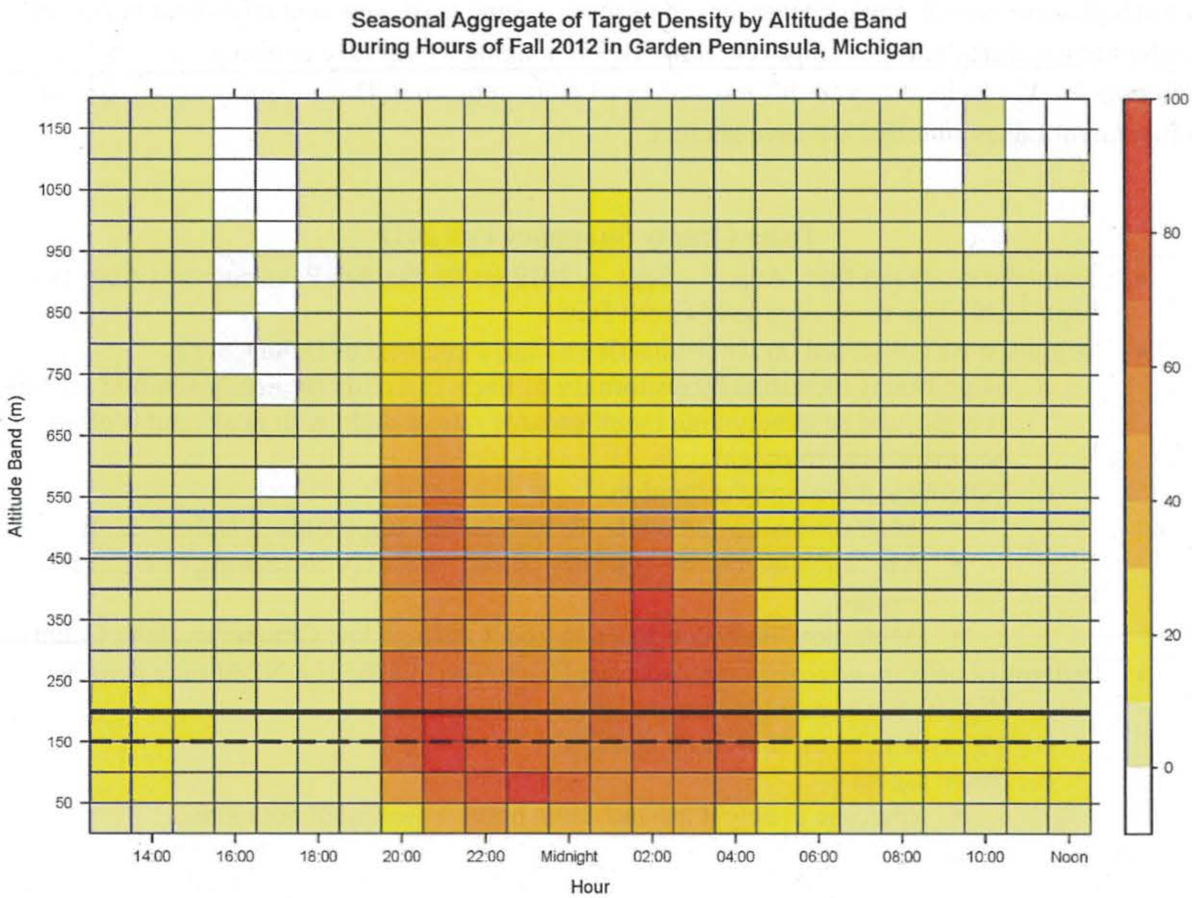

Figure 9. Variation in flight altitudes based on target density. The dark blue and light blue lines represent the nocturnal mean and median target heights, respectively. The dashed black line represents the top of the RSZ at 150 m. The solid black line represents the top of a RSZ of 200 m (height of new turbines available in 2016). Altitude bands are in meters; density is in targets/million cubic meters of area sampled.

When interpreting radar results, it is important to note that the number of targets detected at lower attitudes is affected by two factors that complicate making comparisons of target numbers across various altitudes. First, the VSR beam is triangular shaped with a very narrow beam at ground level widening to about 1.2 km at 2.8 km of altitude. Therefore, the VSR samples an increasingly large area as altitude increases (i.e., greater area sampled, more potential to detect targets). The second, the VSR is also influenced at low altitudes by ground clutter which obscures targets and will vary by site and also by directional orientation at a site. To accurately assess the relative number of targets flying at or below the RSZ, one must adjust for the area sampled by radar at the various altitudes and have an indication of the amount of clutter observed on the VSR at a site. We can provide additional detail on these concepts as needed.

In summary, we have observed heavy concentrations of nocturnal migrants consisting of passerines (song birds) and bats utilizing the Garden Peninsula and the first three miles of shoreline at our site along the western side of Green Bay, in Delta County. We also observed nocturnal migrants flying parallel to shore and crossing bodies of water. Passerines and bats need a place to land as dawn approaches or as they become tired, and land areas near bodies of water are important sites for stopover, either before making a long lake crossing, or afterwards. We have observed this movement to shore at dawn in Delta County as we have at other Great Lakes sites that we have studied.

Delta County Summary Fall 2012

- The radar study ran from Aug. 9 – Sept. 1, 2012 on the Garden Peninsula and Aug. 10 - Sept. 1, 2012 on the west side of Green Bay.
- Migration was observed on the peninsula and the shorelines of Delta County.
  - Migration is identified by uniformity of flight direction (typically south in the fall) at night, and relatively high target passage rate at night with peak counts often occurring near midnight.
  - Patterns and timing of migration
    - Migration occurred while we were at our study sites in Delta County.
    - Migration events are typically pulsed, probably correlating to weather events.
    - Migration likely continued to occur through late October in Delta County.
- Patterns of activity were different between Dawn, Day, Dusk, and Night time periods.
  - Highest target passage rate at night.
  - Movement in towards shore at dawn.
  - Dawn ascent
    - Increase in height around dawn hours observed at both sites.