Wisconsin Stopover Initiative

Handbook for Monitoring Wisconsin's Migratory Landbirds Within the Lake Superior Basin

DULUTH SUPERIOR AREA COMMUNITY FOUNDATION

Private giving for the public good.

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Front cover photo: Kakagon Slough and mouth of the Bad River at Lake Superior. Photo by Luke Wuest/WDNR

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1. Introduction

This Handbook—a dynamic document subject to modification as new information arises—provides a selection of protocols for monitoring migratory landbirds within the Lake Superior Basin of Wisconsin (Fig. 1.), a shoreline area approximately 2,730 miles/4393 km (including islands) in size, across the counties of Douglas, Bayfield, Ashland, and Iron.

The Lake Superior shoreline, like that of all the Great Lakes, is important stopover habitat for migratory birds (Ewert et al. 2006). The lake acts as an ecological barrier to migrants: the Wisconsin shoreline is the last potential stop before birds cross it northward in spring, and the first place for birds to make landfall after crossing southward in fall. The Apostle Islands provide refugia for migrating birds encountering bad weather as they cross the lake (Harris and Jaeger 1978). The coastal wetlands and estuaries provide emergent insects as food resources in spring (Smith et al. 1998) and the Bad River and Brule River corridors also attract concentrations of migrating birds during both seasons (Van Stappen and Doolittle 1993).

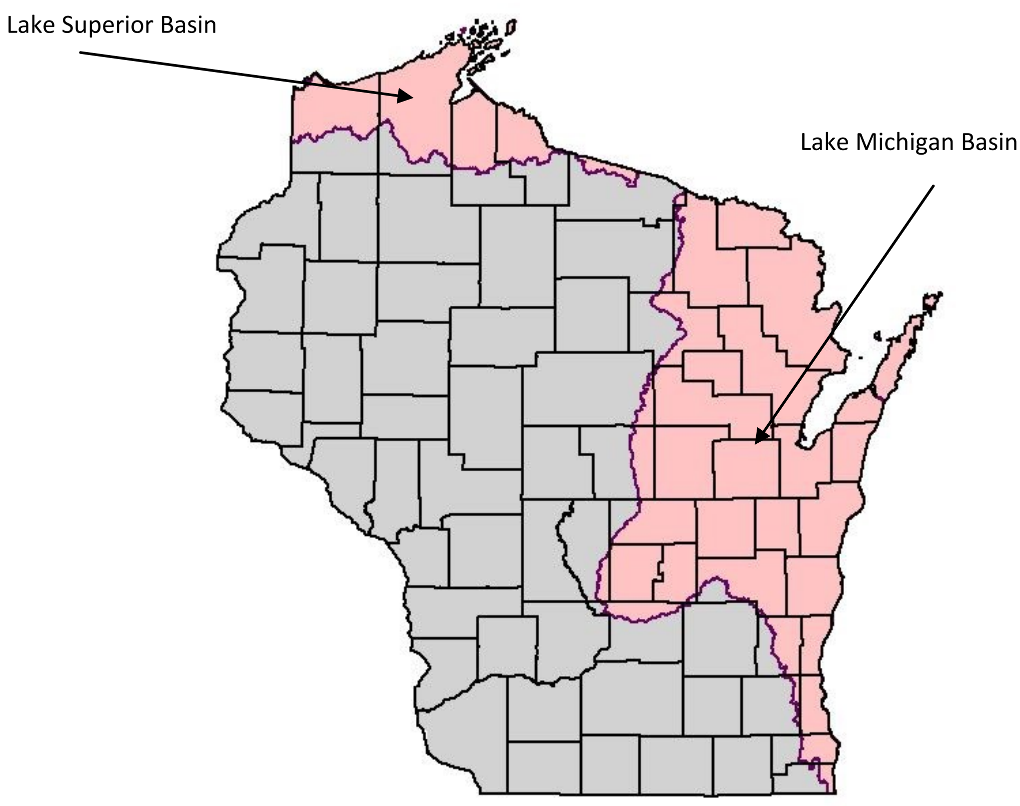

Fig. 1. Pink areas on map show Wisconsin's Great Lakes Basins.

One of the key steps to identifying and protecting these stopover habitats is monitoring the occurrence, distribution, and relative abundance of migratory birds. While populations of breeding and wintering birds have been monitored for many years through a variety of efforts such as the Breeding Bird Survey (BBS) and Christmas Bird Count (CBC), attention has only recently turned to the monitoring of birds during migration. There is still no standardized, nationwide monitoring effort, although regional efforts such as the Northeast Regional Migration Monitoring Network and the Midwest Landbird Migration Monitoring Network[1] (MLMMN) have recently been formed. Monitoring during the migration period captures population data not adequately sampled by either the Breeding Bird Survey or the Christmas Bird Count (Rich et al. 2004), and is important as attention is now shifting to provide for the full life-cycle needs of birds.

The purpose of this Handbook is to not only provide an effective and useful monitoring protocol but to provide the background and rationale for establishing local and basin-wide monitoring programs. We expect that this protocol will meet the needs of:

- Land protection organizations, including The Nature Conservancy, West Wisconsin Land Trust, and the Bayfield Regional Conservancy. These organizations may survey potential acquisition parcels to determine those that have the greatest value for migratory birds.
- Conservation organizations, such as the Wisconsin Stopover Initiative, Wisconsin Bird Conservation Initiative, and the Western Great Lakes Bird and Bat Observatory. These groups may conduct migratory bird surveys as part of a broader state or regional conservation strategy.
- Public and private landowners. These groups may survey for migratory birds for reasons of personal interest, to inform habitat restoration activities, or for documentation of rare or endangered species on their property
- State, Tribal, and Federal agencies, including the US Fish & Wildlife Service, Wisconsin Department of Natural Resources, the National Park Service, the USDA Forest Service, the Lake Superior National Estuarine Research Reserve, the Red Cliff Band of Lake Superior Chippewa Tribe, and the Bad River Band of the Lake Superior Chippewa Tribe. These governmental entities may conduct migratory bird surveys as part of a broader state or regional conservation and/or management plan.
- Academic institutions, such as University of Wisconsin, University of Minnesota, University of Michigan, and the Sigurd Olson Institute of Northland College. Academics may find this this protocol useful as part of teaching field methods for ornithology, or for academic research on topics related to bird migration.

[1] This effort complements the ongoing activities and goals of the MLMMN (for more information on the regional network visit http://midwestbirdmonitoring.ning.com/profiles/blogs/midwest-landbird-migration-monitoring-network-coordinator-hired-b

2. Background Information

2.1 Protecting migratory birds

For the millions of birds that migrate between breeding grounds as far north as Greenland and wintering grounds as far south as Tierra del Fuego, the weeks or months spent in migration may be the most dangerous period of their lives. Birds flying thousands of miles are physiologically stressed and vulnerable to hazardous weather events. Adult mortality during the migratory period may be as high as 85%, and may contribute to the overall decline in populations of some species of birds (Sillett and Holmes 2002). Migrating birds require stopover sites along their migration route where they can rest, refuel, and wait for favorable weather conditions before continuing their flights, in order to arrive at their breeding grounds in good physiological condition (Melhman et al. 2005, Smith and Hatch 2008). Loss and fragmentation of forest habitat along their migration routes presents another hazard to the survival of forest-dependent land birds (Ewert et al. 2006). Consequently, it is important to protect, enhance, or restore a network of suitable habitat parcels to meet migrating birds' needs.

The Wisconsin Stopover Initiative (WISI), launched in 2005, aims to place protection of migratory stopover sites, particularly along the Great Lakes, in the forefront of conservation. Founded by the Department of Natural Resources (DNR) and The Nature Conservancy (TNC) with funding from the Natural Resources Foundation of Wisconsin and State Wildlife Grants, WISI's goals are to protect 30,000 acres (about 25% of total coastal zone acreage) of critical stopover habitat in the Lake Michigan basin and 6,000 acres (about 5% of total coastal zone acreage) in the Lake Superior basin over the next decade.

To meet this challenge, a myriad of partners – including federal, state, and local agencies as well as landowners, conservation organizations, private organizations, and businesses – work together to accomplish the following four key steps: 1. Identify known priority migratory bird concentration sites; 2. Characterize important habitat features of stopover sites; 3. Map the known sites and the priority habitat features in order to pinpoint priority areas; and 4. Apply appropriate conservation measures, such as land acquisitions or habitat restoration, to protect the priority sites. For more details on WISI, its partners, and Great Lakes stopover habitat protection work, please visit www.wisconsinbirds.org/Migratory

2.2 Lake Superior priority bird species

WISI recognizes 43 migratory landbird species of conservation priority in Wisconsin's Great Lakes basins (Grveles et al. 2011). Of these, 23 species are associated with the Lake Superior watershed (Table 1). Common and scientific names of bird species are listed in Appendix A. All priority species are identified by Wisconsin's Wildlife Action Plan (WWAP; WDNR 2005) as Species of Greatest Conservation Need (SGCN) and/or are tracked by Wisconsin's Natural Heritage Inventory Program (NHI). All these species are recognized by the Wisconsin All-bird Conservation Plan except Swainson's Thrush (Kreitinger and Paulios 2007). These 23 species will be of particular interest to WISI and our partners as we monitor landbirds in the Lake Superior basin.

Table 1. Conservation status and concern rankings for 23 priority landbirds in Wisconsin's Lake Superior basin.

Priority Species	Species of Greatest Conservation Need	Tracked by NHI Program	Partners in Flight Continental Concern	
			BCR 12	BCR 23
Upland Sandpiper	Yes	Yes	No	No
American Woodcock	Yes	No	No	No
Black-billed Cuckoo	Yes	No	No	No
Eastern Whip-poor-will	Yes	No	No	No
Red-headed Woodpecker	Yes	No	Yes	Yes
Olive-sided Flycatcher	Yes	Yes	Yes	No
Least Flycatcher	Yes	No	No	No
Veery	Yes	No	No	No
Wood Thrush	Yes	No	Yes	Yes
Swainson's Thrush	No	Yes	No	No
Brown Thrasher	Yes	No	No	No
Golden-winged Warbler	Yes	No	Yes	Yes
Black-throated Blue Warbler	Yes	No	No	No
Connecticut Warbler	Yes	Yes	No	No
Canada Warbler	Yes	No	Yes	No
Field Sparrow	Yes	No	No	No
Vesper Sparrow	Yes	No	No	No
Le Conte's Sparrow	Yes	Yes	No	No
Dickcissel	Yes	No	No	Yes
Bobolink	Yes	No	No	No
Eastern Meadowlark	Yes	No	No	No
Western Meadowlark	Yes	No	No	No
Rusty Blackbird	Yes	No	Yes	No

2.3 The origins of this protocol

In 2012-2013, several northern Wisconsin partners, including land trusts, government agencies, tribal agencies, and university researchers, indicated interest in monitoring migratory birds and their habitats along the Lake Superior shore. Their reasons for monitoring migration range from informing conservation planning and site management to informing community planning and development. In order to address these immediate partner needs, in September 2013 the Wisconsin Stopover Initiative brought together experts from Wisconsin and several other Great Lakes states to determine if a comprehensive monitoring protocol could be developed to inform conservation and management decisions in the area. The goals of this Monitoring Our Migratory Bird Workshop (MOMB) were:

1. Develop a clear understanding among partners of objectives for monitoring migratory birds at various locations along the Lake Superior shoreline.
2. Determine an understanding for how best to monitor migratory birds that will inform land management and conservation decisions in order to maximize stopover habitat quality and conserve air space on Lake Superior.

The overarching question addressed by the workshop then became: Is there one or more techniques that will address these goals? To further define and address the second goal of how best to monitor migratory birds, the participants considered five questions based upon research needs identified by the August 2012 Midwest Migration Monitoring Workshop:

1. How do we measure when, where, and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles, as well as potential changes in land cover as a result of climate change?
2. During spring and fall migration, what habitats at a particular site are most important—which habitats are most used, as indicated by species richness and migrant abundance?
3. For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?
4. What tree and shrub species are important to foraging migrant land birds at a particular site, and how do these vary among seasons and within a season?
5. Relative to the effects of climate change, how are migrant land birds responding to differences in insect and fruit abundance associated with changes in vegetative phenology?

Two breakout groups considered primarily questions 1-3, which involve the spatial and temporal monitoring of migrant landbirds. When considering the movement of migrating birds (question 1), participants differentiated between birds in flight and their use of airspace, and birds on the ground and their use of stopover sites. Depending upon the specific information being sought, which may differ depending upon partner objectives, the experts recommended the use of the following methods for monitoring birds:

- point counts
- mist nets
- radar
- acoustic techniques

Questions four and five, which address birds' use of food resources, were not considered in detail but may require standard vegetation and/or insect sampling techniques as well as remote sensing or landcover data.

A brief summary of the Monitoring Our Migratory Bird Workshop, including workshop goal and objectives, participants, research questions considered, and monitoring techniques recommended by participants, is given in Appendix B.

3. Conservation Goals and Monitoring Objectives

Monitoring programs can be very simple, or complex, depending on the goals and objectives. Before a partner initiates a monitoring program, they should define their conservation goals and monitoring objectives, because these will determine the monitoring strategy and the techniques used. A partner's conservation goal might be as broad as providing a suite of different habitats for a variety of migratory birds, or as specific as restoring appropriate habitat for Golden-winged Warblers.

The Northeast Bird Monitoring Handbook lists several types of monitoring objectives (Lambert et al. 2009). We expect that our partners' objectives will fall into one or more of these categories:

1. Status assessment: measuring the current condition of populations to inform management or conservation decisions and/or establish a baseline for measuring future change. Related objectives may be to inventory species, describe species-habitat relationships, identify critical habitat, or compare present population size to a desired level. We expect that most partners, from landowners to conservation organizations, will carry out this type of monitoring. Examples of status assessments include:
   - A private landowner wishes to know what species and numbers of birds use their property as stopover habitat;
   - A land trust wishes to select among several available properties those that host the most migrants;
   - A conservation organization wishes to compare the use of different habitats in an area.
2. Trend monitoring: repeating surveys at the same locations over time in order to estimate rates of change in occurrence, distribution, abundance, vital rates, and/or health. This type of monitoring may be useful for determining how bird populations respond to habitat management or climate change. An example of trend monitoring is the yearly survey of migrants in an area in order to estimate whether migrant usage increases, decreases, or remains stable over time.
3. Effects monitoring: in addition to monitoring birds, also measuring variables such as landscape or habitat attributes to determine relationships between bird abundance and the environment; e.g. to explain why populations rise or fall. Examples of effects monitoring are:

- A conservation organization surveys migrant populations at progressively longer distances from the lake shore, to determine the effect of this distance on use of stopover habitat.
- A university student surveys migrant populations and takes detailed measurements of the vegetation at several stopover sites to determine which habitats host more migrants and why.

4. Effectiveness monitoring: monitors populations before and after conservation/ management decisions are implemented; this is an important part of adaptive management practices. Partners who work to restore or enhance habitat will likely monitor birds before and after the habitat work to document the effect on birds. Examples of effectiveness monitoring are:

   - Surveying migrant populations in a farm field, followed by surveys five years after the field is planted in trees and shrubs.
   - Surveying migrant populations after timber harvest in a managed forest.

The availability of resources for the monitoring program is as important as the goals and objectives, because this will also affect the monitoring objectives and strategy (Knutson et al. 2008). Resources may consist of personnel, equipment, funding, and time. Personnel may include volunteers or paid workers, and their level of expertise in bird survey techniques is important so that training may be included in the project budget and/or timeline if necessary. Access to consultants such as university researchers, environmental contractors, or statisticians may be important in designing, executing, and analyzing more complex studies. Equipment may be purchased or donated and may include field supplies such as binoculars or mist nets, training materials, access to computers and software for data entry, acoustic monitoring units, and sources of radar data. If personnel time and equipment are to be paid for, funding sources should be arranged before the project begins. Finally, it is important to have a timeline: will the study last for one season or many? The Wisconsin Stopover Initiative can work with partners to design monitoring programs or to help secure funding that will accomplish their objectives.

4. Monitoring Techniques

4.1 Point Counts

4.1.1 Overview

This is the most widely used technique for bird monitoring, and some variation of it is used for most breeding bird surveys (Hutto et al. 1986, Ralph et al.1993, Nur et al. 1999). The observer stands at a point and notes every bird seen or heard for a pre-determined time period. Thus it is used for birds using the habitat, as opposed to birds aloft, although birds flying over the count area may be noted. The "count circle" around the observer may have a fixed radius, i.e. only birds within a certain distance of the observer are noted, or may have no limit. Bird abundance, species richness, and habitat associations can all be determined through the use of point counts; thus it is an appropriate method for answering most aspects of questions 1-4 from the MOMB 2013 workshop.

Many studies of migratory birds have used the line transect method, in which an observer counts birds while walking a straight line of fixed length through a habitat (see for example Rodewald and Brittingham 2004, France et al. 2012, Peterson MOMB 2013). We recommend using point counts instead of line transects for several reasons: line transects are logistically more difficult to establish than points; point counts may be easily accomplished in any type of landscape or terrain, in large or small areas; and migrant studies using point counts can be more easily compared with other migration studies or integrated with results from breeding bird studies if partners wish to incorporate both into a full life-cycle population model. The duration of a point count is flexible, typically from three to five minutes; if the count is conducted so that birds are recorded during the 1-minute interval in which they are detected, then the data from 0-3 minutes can be integrated with Breeding Bird Survey data, and data from 0-5 minutes can be integrated with to other breeding bird censuses (Knutson et al. 2008, Ralph et al. 1995, Farnsworth et al. 2005). In certain cases a longer count may be appropriate; Ralph et al. (1993) recommend a 10-minute count for areas in which travel time between points is greater than 15 minutes. In the Lake Superior basin this would include surveys that 1) monitor more than one island; 2) monitor points on both an island and the mainland; or 3) monitor a very large area on the mainland with points spaced far apart.

The number and location of sampling points will be determined by the size of the area that a partner wishes to monitor, and their objectives. Large areas may require several points to adequately sample the area, and if habitat associations of migrants are a monitoring objective, one or more points may be located in each habitat type. Because point counts should be separated by at least 250 meters in order to avoid double-counting birds, no more than one point count may be conducted in a 12-acre area.

Point counts as described by Ralph et al. (1993) are conducted at points randomly located in an area. A disadvantage of randomly locating points is that they may miss sampling migrating birds, which tend to move as mixed flocks through the habitat. Associations of migrants with edge-dominated and early successional habitat are now well known (Rodewald and Brittingham 2002, 2004). If the objective is to count as many birds as possible, we recommend locating points in areas where they will be most likely to sample migrants, such as along habitat edges. If there is no early successional or edge habitat in the area, or if it is otherwise unclear where migrants might concentrate, points should be randomly located.. Point counts may have a count circle with an unlimited radius; however, use of a 25-meter or 50-meter circle will allow densities of birds to be determined.

In an attempt to establish a long-term migration monitoring program, surveys on the Apostle Islands, Van Stappen and Doolittle (1993 and 1995) placed point count stations in areas known for migrant concentrations and at vantage points for excellent viewing of birds. They also extended the observation period to 30 minutes in order to count birds moving through the habitat. On one island, this method also permitted counting birds as departing from the island across a sandspit.

In spring 2015, point counts were used to document migration throughout May with peak numbers occurring during the third week at two mainland sites along the Lake Superior shore (Grveles and Staffen, unpublished data). Standard point count methods used were based on Ralph et al. (1995) except the point radius was not fixed and point stations were located near edges of specific habitats rather than randomly placed.

The unique geography of the Lake Superior basin and the unpredictable weather often encountered in the spring may result in conditions in which these recommended count procedures may not be appropriate or effective. On Clough Island in spring 2014, traditional point count methods were not fruitful for recording birds and were abandoned in favor of counting birds seen and heard while walking through each habitat (Staffen and Grveles, unpublished data). Migration had been delayed and compressed into the last two weeks of May most likely due to unseasonably cold temperatures and snow persisting into late May. The delay may have shortened the amount of time birds spent stopping over on Clough Island, making it difficult to count them from stationary points.

Point counts typically sample breeding birds only once or twice during the breeding season. However, birds migrate through an area either continuously or in pulses depending on weather conditions, so the migrant assemblage at a site may change daily (Dunn 2005). The amount of time birds stay at stopover sites may vary from hours to several days, depending on weather, bird species, and habitat quality (Ewert et al. 2006). To trade off the risks of missing migrants that pass through an area with the risk of double-counting birds that remain for several days, we recommend:

- Conducting counts every 4-6 days during the migratory period. The number of counts will depend on the partner's resources.

- In situations where partners expect “migration compression” to be a recurring issue (see above example from Clough Island) and counts cannot be separated by several days,
- consider an alternate method of bird monitoring such as mist netting or acoustic monitoring.
- Sampling fewer points on more days to capture a more complete profile of migration through that area, if funds are limited.

4.1.2 Point Count Procedure

This point count procedure is based on that of Ralph et al. (1995), with the exception that the survey points are not randomly generated, but located in habitats that migrants are most likely to use for stopover. Methods should also be comparable to other migration studies and ideally able to integrate with breeding bird studies so that populations can be compared throughout their full life cycle (MOMB, Appendix A).

For example, the standard point count duration is five minutes for migration surveys and breeding bird surveys with short travel time between points (Ralph et al. 1995); however, some breeding bird studies, e.g. the Boreal Avian Modelling project (BAM 2015), use 10-minute counts, and Ralph et al. (1995) recommend a 10-minute count when travel time between points is greater than 15 minutes. For areas that are difficult to access, such as islands, a 10-minute or longer count may be appropriate.

Survey points. Points should be identified prior to the beginning of the study. We recommend locating survey points in areas with east-facing slopes (where sun is most prevalent early in morning), forest edges, and shrubby transition zones at base of hardwood forests surrounding lakes, streams, and marshes or wetlands where insects are emerging. Survey points should be separated by at least 250 meters and not located along a primary road, although proximity to a secondary road or trail will allow easier access. In an off-road situation, 6-12 5-minute point counts can be conducted in a morning (Ralph et al. 1993), so if a series of points is to be surveyed, an observer should try to visit all the points before the survey period begins to be sure that the series can be completed in one day.

If the survey points are first determined using maps and/or aerial imagery, they should be ground-truthed before the survey period to ensure that the points are accessible and the vegetation appropriate for migrants, since conditions on the ground may have changed after the maps/imagery were created. The coordinates should be stored in a GPS unit, and the points should preferably be marked with flagging tape or by some other method.

Count Period. Survey should take place from sunrise to 10:00 AM CDT only. Surveys should be separated by at least 3 days (weather dependent) during the period from approximately April 1 – May 30 in spring and/or August 15 – October 15 in fall. If there are multiple observers, sites, and points, observers should be rotated among sites to reduce observer bias in bird detections and count times should be varied among the points (i.e. a given point should be surveyed at different times of the morning over the course of the sampling period). Surveys should not be conducted during periods of heavy rain or high winds.

Materials. Data sheets with clipboard, digital timer, binoculars, field guide (paper or digital)

Count method and data recording. Weather conditions (temperature, wind, cloud cover, and precipitation) are recorded at the beginning and end of each survey day.

The observer stands at the survey point (Fig. 2.) and records all birds seen or heard in the count period, including the following information:

- Species
- Time interval in which the species was observed (0-3 minutes, 4-5 minutes, 6-10 minutes (Ralph et al. 1995))
- Method of observation (V=visual, A=auditory, B=both)
- Number of individuals of each species
- Gender of individuals (M=male, F=female, U=unknown)
- Associated habitat, if possible (C=canopy, U=sub-canopy, SH=shrub, G=ground layer) and behavior of birds observed (i.e. moving, singing, foraging, associating with other species).
- Birds that pass over the count area during the survey should be noted as flyovers

Unknown birds should be identified as close to species as possible; e.g. unknown raptor, unknown woodpecker, unknown warbler.

An example of a point count data sheet is given in Appendix C. A list of resources for training in bird identification is given in Appendix D.

Fig.2. Point count method employed by Peggy Burkman at Apostle Islands National Lakeshore. Photo by Julie Van Stappen.

4.2 Mist Netting

4.2.1 Overview

The capture and banding of birds may be used alone or in combination with point counts to monitor birds in both the breeding and migratory periods (Hussel and Ralph 2005). It is an appropriate method for addressing questions 1-4 from the MOMB 2013 workshop, and the only method that will determine condition of migrants during stopover. An array of mist nets are operated for a number of hours each day, each bird captured is fitted with a metal band with a unique number, and a variety of data are recorded on its physical condition including age, sex, weight, amount of body fat, and breeding condition. If a bird is already banded when it is captured, its band number can be searched to find where and when it was banded. Blood samples can be taken to determine plasma lipid metabolite and stress hormone levels, and breath samples have been used to determine whether aquatic or terrestrial insects comprise the recent diet (McDade et al. 2011). If a bird is recaptured in the same season, the quality of the habitat may be inferred from changes in its body condition and length of time it remains at the stopover site. Recapture of birds at the same site in subsequent years gives an indication of stopover site fidelity.

Advantages of the mist netting include: it minimizes observer differences in ability to detect species; it detects birds that are secretive and do not vocalize often, which may be missed by point counts; there is no risk of double-counting, so surveys may be conducted every day; and physical condition and demographic information are obtained for each bird. Disadvantages of this method include: it requires special skills, training, and permitted personnel; it is limited by weather since birds should not be captured in rain or cold temperatures; some bird species, such as those that tend to remain in the canopy and might be heard or seen, are not captured (Hussel and Ralph 1998); and costs can be higher than point counts due to equipment needs.

Where point counts sample birds at a number of different locations on a given day, mist netting is typically carried out at a banding station where multiple mist nets are deployed in one location. Typically two or more people are necessary to set up and monitor nets and extract and process birds (Fig.3.). Thus, although mist nets may be deployed in the field at specific or remote locations (Holberton 2013), the method is not as flexible or "portable" as point counts.

4.2.2 Mist Netting Procedures

The MOMB Workshop experts recommended establishing a master banding station, perhaps on the Bayfield Peninsula, that would operate daily during both migration seasons as the hub of a network of intermittent banding stations. It is important to standardize procedures, equipment, and data collection with those used at other banding stations such as Black Swamp

Bird Observatory[3], Hawk Ridge Bird Observatory[4], or Monitoring Avian Productivity Survivorship (MAPS)[5] banding stations (MOMB 2013).

- Nets should be 4-tier, 30 mm black polyester mesh, 2.5 m X 12 m in size.
- Nets should be opened one-half hour before sunrise and operated for six hours, every day during the migration period. They should be opened and closed in the same order.
- Nets should not be operated in wind, rain, or extreme heat or cold.
- Recaptures provide the most important data in a constant-effort mist netting program, so if there are multiple birds to be processed, they have a higher priority than unbanded birds.
- Birds should receive a standard US Fish & Wildlife service leg band. Data should be collected in the following order (Ralph et al. 1993):
    - ◊ Band number (if a recapture)
    - ◊ Species; sex and age using plumage characteristics (Pyle 1997)
    - ◊ Closed wing chord length
    - ◊ Body mass
    - ◊ Fat score on a six-point scale (Helms and Drury 1960); this differs from the 7-point scale used in the MAPS program (DeSante 2015) but was specifically recommended by the experts (MOMB 2013).
    - ◊ Net-round at which the bird was captured

Fig. 3. Banding crew approaches mist net to remove captured migrants on the Bayfield Peninsula in spring 2015. (Right) Philadelphia Vireo caught in mist net for banding and data collection. Photos by Ryan Brady.

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3 http://www.bsbo.org/research.html
4 http://hawkridge.org
5 http://www.birdpop.org/pages/maps.php

The number of net-hours is the number of 12-meter nets times the number of hours they were open. Capture rates for the day are recorded as birds per net-hour, and per season as bird per 100 net-hours. An example data sheet from the MAPS program may be found at http://www.birdpop.org/docs/misc/MAPS-Materials-MAPS-Banding-Data-Sheet-2015.pdf

A good number of mist nets per banding station is 10, but partners with fewer resources or a smaller site may operate fewer nets, in which case supplementing the study with point counts is recommended (Hussel and Ralph 2005). In this case, survey points should be separated from the nets by at least 100 meters and located in edge or early successional habitat as described in the point count procedure. A point count of at least five minutes will allow comparison with data from other stations, e.g. Black Swamp Bird Observatory, that use a five-minute count (Shieldcastle 2014).

4.3 Acoustic Monitoring

4.3.1 Overview

Acoustic monitoring is most commonly used to detect nocturnal flight calls (short one- or two-note calls given during flight) of birds passing overhead during migration (Farnsworth 2005, Holberton et al. 2012, Sanders and Mennill 2014). It is especially useful in areas that are remote or otherwise difficult to access for regular sampling, such as islands. Acoustic data is also used to supplement point count, banding, or radar data. One or more digital recording units are placed at pre-selected sites in the field for the migratory season and data, sometimes thousands of hours, are later analyzed using appropriate software packages.

Acoustic monitoring samples a different population of migrants than point counts or banding: it detects nocturnal migrants passing overhead, as opposed to diurnal migrants or those stopping over in a habitat, although studies in the Great Lakes have shown good correlations between acoustic detections and mist net detections of migrating birds (Sanders and Mennill 2014). Because the range of detection by microphones is not yet well understood, and movement of migratory flocks may be very localized (Sanders and Mennill 2014) it may be advisable to deploy an array of detectors over an area.

Advantages of acoustic monitoring include: data recorders can be placed in remote areas and collected at the end of the season, few personnel are needed for operation, and birds can be identified to species or species group (species that give similar flight calls). Radar data also provide information on nocturnal bird migratory movements, but does not identify birds to species or indicate flock composition. Disadvantages are the necessity of purchasing and operating equipment and software, and complexity of data analysis. Another disadvantage of acoustic sampling is that some birds, such as tyrant flycatchers, vireos, and mimids, do not give flight calls (Farnsworth 2005).

Acoustic monitoring may be very useful in determining how migrant flocks use airspace, particularly in areas where wind turbines or communications towers may be sited. The number and timing of calls given in an area can indicate whether migrants are taking off or leaving (Holberton MOMB 2013, Appendix A). In areas where partners require more detailed information on migrant species richness, acoustic detectors could first be deployed over a large area to identify areas where migrants concentrate, so that point counts, mist-netting, or other ground-based monitoring can be conducted (Peterson and Horton 2012; MOMB Workshop 2013, Appendix A).

4.3.2 Acoustic Monitoring Procedures

Equipment. Rapid advances in technology have made relatively low-cost acoustic recording systems, consisting of a digital recorder and microphone, available for monitoring night flight calls of migrating birds (Fig. 4). Digital recorders and microphones can be purchased from standard vendors, or the company Wildlife Acoustics (Concord, Massachusetts)[6] which manufactures specialty recorders, microphones, and software for monitoring birds, bats, and cetaceans. For partners with limited resources, an alternative is available from the non-profit organization Old Bird, Inc.[7], which makes available on its website instructions for construction of a low-cost microphone and housing, which will transmit flight calls directly to a personal computer or to a recording unit (Holberton, MOMB 2013, Appendix A).

Fig. 4. Acoustic monitoring setup. Photo by Becky Horton/USFWS

Location and operation. A series of detectors may be deployed in transects to study how the density of migrants varies across the landscape, for example at a series of distances inland from a shoreline (Peterson and Horton 2013). Acoustic monitors may be deployed at banding stations or at the locations of point counts to supplement the data collected by the daytime surveys. They may be deployed at remote areas that are difficult to access, such as islands, to collect data in lieu of point counts or mist-netting. They may be deployed singly in a small survey area, or in an array over a large area to determine where migrants concentrate and suggest a location for point count or mist net surveys (MOMB 2013, Appendix A).

6 http://www.wildlifeacoustics.com
7 http://www.oldbird.org

The microphone for an acoustic monitoring system should be mounted above the ground, for example on a pole, tall ladder, or rooftop, to minimize interference from frog and insect calls which can mask bird flight calls or trigger automatic detection software, which responds to noises of particular frequencies. Crickets can have calls similar in duration and frequency to warbler and sparrow flight calls and can result in thousands of false detections in an evening. Similarly, the spring peeper (*Hyla crucifer*) can reduce the ability to accurately detect thrushes (Evans 2012, Sanders and Mennill 2014). The monitoring system should not be located near extensive areas of bright artificial light such as parking lots and convenience stores because birds may become disoriented in fog or low cloud cover and fly toward these lights and call more rapidly (Evans 2012).

The Nocturnal Flight Call Count Protocol developed by eBird[8] recommends programming the monitoring system to record calls during the period from astronomical dusk to astronomical dawn. This ensures that the calls recorded are the flight calls of birds migrating overhead, and not birds calling from the ground shortly after dusk or just before dawn (Farnsworth 2005, Sanders 2014). The astronomical twilight hours for a location may be obtained at Weather Underground[9] at the location's weather forecast page. If partners wish to know whether migrants are departing from or arriving at an area, the monitoring time period can be extended to include the dawn and dusk hours.

Call analysis. Once the night flight calls are recorded, they are typically visualized as sound spectrograms with appropriate software and compared to reference libraries of sound recordings for identification (Fig. 5). Software packages include Syrinx-PC[10] (J. Burt, Seattle, Washington, USA), Raven and Raven Lite[11] (Cornell University, Ithaca, New York, USA), and software available as free downloads from Oldbird, Inc. Libraries of reference recordings include Flight Calls of Migratory Birds: Eastern North American Landbirds CD-ROM (Evans and O'Brien 2002), and calls and spectrograms available at the websites Oldbird.org, Xeno-Canto.org, and Cornell Lab of Ornithology. Some birds can be identified to species by their flight calls, while some can only be identified to species group due to the similarity of their calls. (Evans 2012, Sanders 2014).

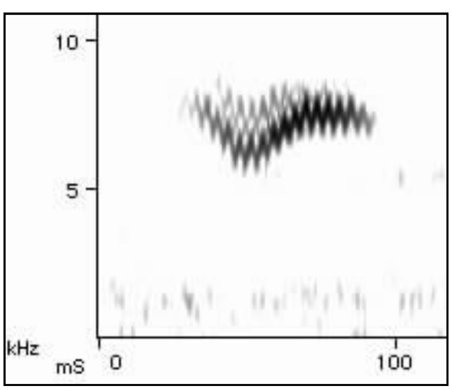

Fig. 5 Sonogram of Black-and-white Warbler courtesy Old Bird, Inc. http://oldbird.org/Library.htm

8 http://ebird.org/content/ebird/about/nfc-count-protocol
9 http://www.wunderground.com
10 http://syrinxpc.com/
11 http://www.birds.cornell.edu/brp/raven/RavenOverview.html

4.4 Radar Data

4.4.1 Overview

This is another technique that gives information on movements of migrants through airspace, and along with acoustic monitoring, is appropriate for addressing aspects of Question 1 of the MOMB 2013 workshop. Airborne birds, bats, and even insects are detected by radar, and the radar reflectivity is correlated with the density of birds in the airspace (Gauthreaux and Belser 1998). "Radar data" may refer to data collected by one of various types of radar technology, including Doppler weather radar (NexRAD or WSR-88D) from permanent stations, mobile marine radar, military tracking radar, and other pencil-beam radars (USGS 2015). Recent studies have used self-contained, mobile radar units specifically designed to detect, track, and count migrating birds and bats (Bowden et al. 2015). It is possible to determine direction, speed, height, and density of migrant flocks, as well as changes in flock movements; for example, the "dawn ascent" of migrants is discernable on radar, and migrants over water have been observed returning to land at dawn or in the face of a storm front (Bowden et al. 2015).

Bird movements have been studied by radar since the 1960's, and hundreds of papers have been published. The United States Geological Survey (USGS) at the Fort Collins Science Center maintains a website[12] that includes an overview of radar use for detecting migratory "aerofauna", as well as bibliographies of articles on radar biology, including:

- General Radar Articles
- Weather Surveillance Radar
- Modified Portable Radars
- Tracking Radar
- Radar Operation, Upgrades, and Data Access
- International Radar Articles
- Bat and Insect Articles
- Miscellaneous Radar Articles (USGS 2015)

Like acoustic monitoring, radar data can be used to estimate migration over less-accessible areas. Radar and acoustic monitoring can be used alone or in concert to determine areas where concentrated movements of migrants occur, and indicate where banding or other monitoring stations should be located, and to inform wind turbine and communication tower siting (Bonter et al. 2009). The technology is rapidly evolving, and recent results suggest that studies to date may have underestimated the risk of wind turbines to birds because there may be more birds flying within the height of turbine rotor swept zone than represented by average altitude of bird targets on radar (Bowden et al. 2015).

[12] https://www.fort.usgs.gov/radar

Advantages of avian radar are that it can provide continuous, unbiased sampling for the full 24-hour period, and the data can be viewed in real time (Rathbun, MOMB 2013, Appendix A). A drawback is that is does not distinguish birds vs. bats, identify birds to species, or give an exact count of targets, although recent software developments have improved the results from NEXRAD data (Buler and Dawson 2012). Mobile radar units require specialized equipment and software, and personnel trained in its use and data interpretation (Rathbun, MOMB 2013, Bowden et al. 2015).

4.4.2 Radar detection procedures

Unlike point counts and mist-netting surveys, there are no standard procedures for field collection of radar data, including equipment settings, data processing, or ground-truthing (correlating the radar observations with numbers of birds detected on the ground through other survey methods; Ruth 2007). Partners will likely choose either Doppler radar or mobile marine radar for their information. Doppler radar has limited resolution and thus is better at describing broad, regional migration patterns, whereas mobile radar is better at providing site-specific information on migrant use of the airspace, especially that occupied by communication towers, wind turbines, tall transmission lines, tall bridges, and tall buildings (Fischer et al. 2012, Ruth 2007). Both these method require some correction for the fact that land features and human infrastructure can block the radar beams, and spurious radar echoes ("clutter") can be created under certain conditions. This is a concern in the Lake Superior basin, where steep topography may block the radar beams in places.

Weather surveillance (Doppler, NexRAD) radar stations are operated by the National Weather Service or the Department of Defense, and data are available for free download from the National Climatic Data Center[13] . Analysis, however, is complex. For example, Buler and Dawson (2012) studied migratory stopover using data from radar stations across the Northeastern US, first excluding data from areas where the radar beam was blocked, then correcting for measurement bias due to radar beam spread (Buler and Diehl 2009) and processing the reflectivity data to derive bird densities using specialized software developed at the University of Delaware. The NexRAD data for the Lake Superior basin would originate in Duluth, Minnesota and thus would be of limited utility on the east side of the Bayfield peninsula.

The Avian Radar Project of the U. S. Fish and Wildlife Service[14] operates two Merlin (DeTect Inc., Asheville, NC) mobile avian radar units along the Great Lakes shorelines (Fig. 6). They were deployed on Lake Superior in Bayfield, Wisconsin and Manitou, Minnesota in autumn 2014 (USFWS 2015). Each unit has two marine radar antennas that scan both horizontally (to determine bird movement direction) and vertically (to determine the number and height of

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[13] https://www.ncdc.noaa.gov/data-access/radar-data
[14] http://www.fws.gov/radar/team/index.html

Fig. 6. Mobile marine radar setup. Photo courtesy USFWS.

birds), as well as computers for automated data processing. Micro-site selection is important for the placement of the units to avoid radar beam blockage and minimize clutter. The settings of the units and software must also be adjusted according to the conditions at the site, so that the unit correctly identifies and tracks targets. A recent study by Bowden et al. (2015) describes the steps involved in radar set-up, data collection, and data processing for studies that were carried out on the east and west Lake Michigan shoreline. Merlin avian radar units can be purchased, leased, or rented from DeTect Inc.[15]

Partners wishing to incorporate radar data into their monitoring efforts will likely collaborate with agencies that have access to state-of-the art technologies and personnel, such as the University of Wisconsin, the U. S. Fish & Wildlife Service, or the US Geological Survey (Ruth 2007). The Wisconsin Stopover Initiative can facilitate this collaboration so that partners can select a radar methodology that meets their needs.

[15] http://www.detect-inc.com/avian.html

4.5 Vegetation Measurements

4.5.1. Overview

Some type of vegetation assessment is needed in order to answer Questions 2-5 from the MOMB workshop. Coarse-scale assessment may be sufficient to address Questions 2 and 3 regarding migrant use of habitats at a particular site. Land cover data, such as are available from the National Land Cover Dataset[16] or Wisconsin Land Cover Data (Wiscland[17]) will indicate habitat types, e.g. coniferous forest, deciduous forest, woody wetland. The Wiscland data is more detailed. Alternatively, a narrative description of the habitat may be given, e.g. "Streamside, birch/aspen canopy, willow/alder thicket", along with sketches or photographs (Knutson et al. 2008).

Questions 4 and 5, which address migrant use of tree and shrub species, may require a more detailed assessment of vegetation at the site. A Rapid Assessment of Vegetation (Knutson et al. 2008) may serve the partners' purposes. Such procedures typically estimate habitat variables such as slope and aspect, canopy height and closure, understory density, and species composition of trees and shrubs within a plot at the survey point. Sketches or photographs may accompany the assessment. A data form example from the US Fish and Wildlife Service Landbird Monitoring Protocol (Knutson et al. 2008) is included in Appendix F.

For detailed studies, in which vegetation variables are incorporated into a model that explains migrant occupancy, partners may wish to conduct quantitative vegetation assessments. In addition to measuring variables such as canopy height and closure, monitors attempt to identify trees, shrubs, and ground cover, as well as measure diameter at breast height (dbh) of large trees and count stems of small trees and shrubs. Two such procedures that have been used for studies of migratory bird habitat are the 11-m radius circular plot-based method of James and Schugart (1970), and the point-centered quarter method along a transect (Mitchell 2007, Appendix G).

4.5.2 Vegetation measurement procedures

Materials: Digital camera; data sheets and clipboard; compass, flags or flagging tape for marking plots; meter stick; tape measure (metric); diameter tape for measuring tree size (optional; alternatively, measure with a measuring tape and divide value by 3.14); clinometer for measuring slope and canopy height.

Rapid vegetation assessment. An example procedure from the US Fish and Wildlife Service Landbird Monitoring Protocol (Knutson et al. 2008) is included in Appendix D. Partners may

[16] http://www.mrlc.gov/finddata.php
[17] http://dnr.wi.gov/maps/gis/datalandcover.html

elect not to measure some of these variables, and/or to add others, depending on the data desired. Possible additional variables include slope and aspect, an estimate of tree/shrub phenology (i.e. percent leaf-out), and ground vegetation height. The vegetation plot is centered at the location of the point count. We recommend leaf phenology estimates and ground cover height measurements be conducted several times during spring migration.

Detailed vegetation assessments. For studies in which vegetation data are used in a model to explain migrant abundance, one or more separate visits to each survey point will be necessary in order to perform all the measurements. There is no standard for vegetation data, although the methods of James and Schugart (1970) are widely used. The type and amount of data gathered are somewhat at the partner's discretion, depending upon the research question or goal. For example, leaf phenology and canopy height and composition are relevant to birds that forage on leaf buds and insects in the canopy, while ground cover height and composition are relevant to birds foraging on the ground. The habitat metrics should be defined when carrying out the analysis and documenting the results; for example: average canopy closure, number of shrub stems, average ground vegetation height, etc. Partners with research questions will be familiar with the literature on their topic of interest and will likely use similar vegetation measurements.

Figure 7. Vegetation sampling plot at a northern Wisconsin muskeg.

5. Designing the study

In considering the questions that need to be answered regarding migrants' use of land and airspace in the Lake Superior Basin, the MOMB Workshop experts recommended the use of point counts, mist netting, acoustic surveys, and radar data. How WISI partners employ these techniques will depend upon the partners' goals and objectives, timeline, and resources. Following is a brief overview of how to proceed with a monitoring program, targeting especially partners who are new to monitoring of migratory birds.

5.1 Technique selection

In the Landbird Monitoring Protocol for the U. S. Fish and Wildlife Service, Knutson et al. (2008) advise partners to "begin with the end in mind". Partners should determine what information they wish to obtain from migrant monitoring. The goal may be a species list and count of migrants that use an area, a comparison of the species richness and abundance in different habitats or on different properties, or a statistical model that describes the species-habitat relationships in an area. Figure 8 shows a simple decision tree that partners can use to determine which techniques would be appropriate for meeting their goals and objectives.

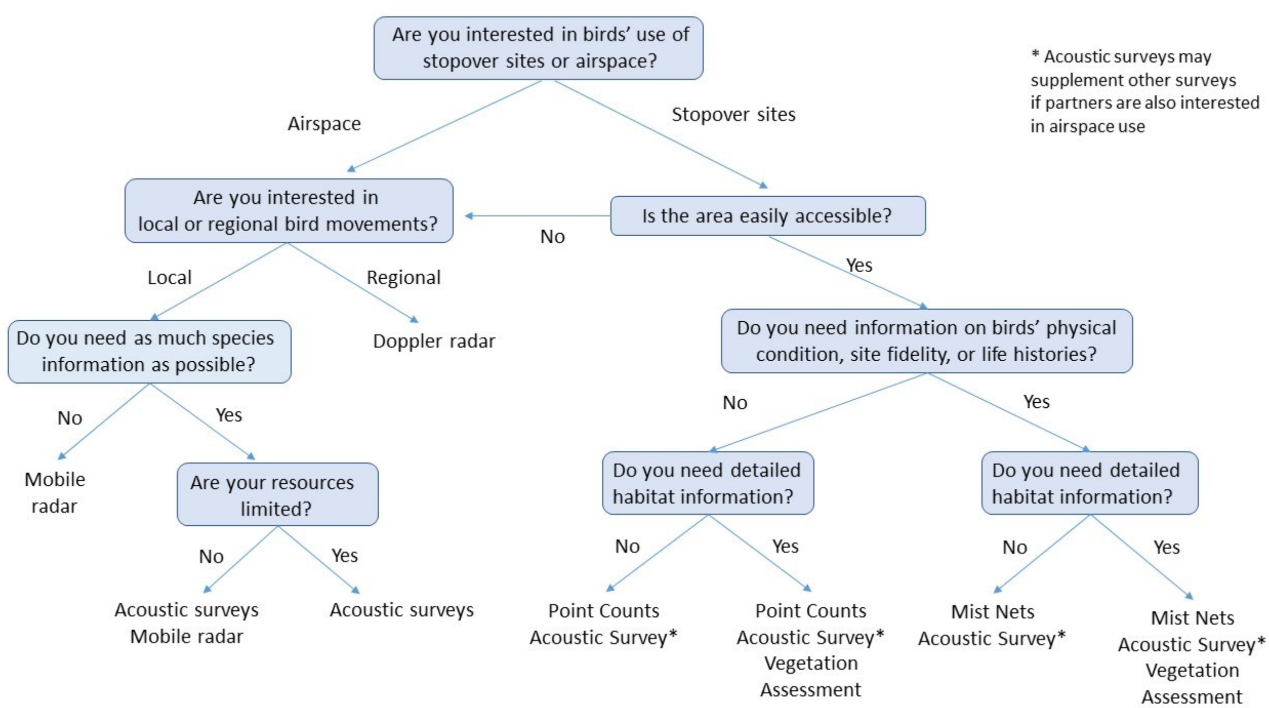

Figure 8. Decision tree for selecting monitoring techniques

In choosing techniques and planning their migrant studies, partners should also consider their timeline and resources—funds, equipment, and personnel, because some techniques, as noted in Section 3, require specialized equipment and training.

5.2 Data collection and analysis

A migration monitoring study need not be complicated. For partners that want to know the migrants using an area, a simple species inventory may suffice. In this case, **point counts** will give an index of migrant abundance, species richness, and species diversity. If these data are gathered over time in a standard fashion (Ralph et al. 1993), they may be incorporated into larger or more complex studies later (Nur et al. 1999).

Because migrant birds at a site may change daily, point counts should be conducted at least weekly during the migration season, depending on weather and available resources. The number of points surveyed will also depend on resources, the physical size of the area involved, and the area's different habitats. If the area is large, several point counts may be appropriate; they should be conducted the same number of times during the season, and on the same days. The time of day that each point is surveyed should be varied, and if there are multiple observers, the observers should be rotated between points (Ralph et al. 1993).

Banding stations, which do not have the risk of double-counting birds, should be operated every day that weather permits. **Acoustic detectors** operate nightly and during morning flights, and **radar** data can be collected continuously.

One issue that will be encountered, particularly toward the end of the spring migratory period, is the separation of migrant and resident birds. Bird species with a large breeding range may be migrating through an area to a more northern part of their range, or they may be arriving on their breeding territories. If partners wish to obtain only information on migrant birds, they should conduct surveys once or twice during the month of June, in the breeding season, and remove detected breeding species from the list of migrants.

Vegetation assessments, both rapid and detailed, should be conducted at least once during the season. Variables that may change during the season, such as leaf phenology or ground cover height, if they are of interest to the partner, should be measured or estimated at each visit.

Because the bird assemblages sampled during migration is by definition not a closed population, the counts are not adjusted for detectability, as breeding bird counts commonly are. It is recognized that the detection probability will depend on several variables, including species, site conditions, year, and observer, and that the count represents an index of the true number of birds present. The number of birds observed can be plotted versus time to give a profile of migration intensity at a point or at the site. Since the points are surveyed several times during the season, the total number of birds of each species per point can be expressed as: 1) the sum of birds detected over all the surveys, 2) the average number of birds per point, or 3) the maximum number of each species detected during the season (Nur et al. 1999).

If there are several habitats to be surveyed, for example forest/grassland edge, forest/marsh edge, beach ridge, etc., ideally each type should be sampled to increase the chances of intercepting concentrations of migrants. If partners want information on which habitats are preferred, information on vegetation can be recorded. The data can be subjected to simple statistical tests such as a t-test (for two habitat types) or Analysis of Variance (ANOVA, for three or more habitat types) to determine if migrant abundance is higher in a certain habitat. If the sampling effort is equal at all sites, t-test or ANOVA will indicate which habitat or site hosts more migrants, or if the numbers at each site are essentially the same. This approach is also appropriate for partners selecting among two or more sites for conservation or management.

If a partner wishes to model habitat associations of migrants, techniques include correlation analysis, regression models (linear, logistic, and Poisson, stepwise and multiple regression), classification and regression trees, and ordination techniques such as Principal Components analysis or canonical correspondence analysis (Knutson et al. 2008). Partners conducting these analyses should have access to a statistician or statistical programming packages. Introductory texts for non-statisticians include Dytham 2003 and Gotelli and Ellison 2004.

6. Summary

The interest in migratory ecology is expanding rapidly as more attention is focused on the needs of birds during their full life cycle, with the migratory period being perhaps the most hazardous portion of a bird's life. The creation of regional migration monitoring networks illustrates the need to identify and address knowledge gaps in the migratory connectivity of landbirds. This handbook is intended to provide partners with guidance on standardized monitoring procedures to collect data that can be integrated into existing databases.

Technology is evolving, particularly in remote sensing of birds and vegetation, and procedures will change as techniques such as radar and acoustic monitoring become streamlined and more accessible to partners. This handbook is thus a dynamic document that will be changed and updated as partners gather more information about the unique conditions that exist in the Lake Superior Basin.

For questions and information contact Kim Grveles, Wisconsin Stopover Initiative migratory bird biologist at kim.grveles@wisconsin.gov.

Bayfield Peninsula and Apostle Islands. Photo by Luke Wuest/WDNR.

Literature Cited

Bonter, D., S. A. Gauthreaux, Jr., and T. M. Donovan. 2009. Characteristics of important stopover locations for migrating birds: remote sensing with radar in the Great Lakes Basin. Conservation Biology
23:440-448.

Boreal Avian Modelling Project. 2015. BAM Guidance for conducting avian point count surveys. Http://www.detect-inc.com/avian.html , accessed 8 August, 2015.

Bowden, T. S., E. C. Olson, N. A. Rathbun, D. C. Nolfi, R. L. Horton, D. J. Larson, and J. C. Gosse. 2015. Great Lakes Avian Radar Technical Report Huron and Oceana Counties, Michigan. U.S. Department of the Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-2015.

Buler, J. J., and D. K. Dawson. 2012. Radar analysis of fall bird migration stopover sites in the Northeast U.S. Final Report. Cooperative Agreement USGS and University of Delaware.

Buler, J.J., Diehl, R.H., 2009. Quantifying bird density during migratory stopover using weather surveillance radar. IEEE Transactions on Geoscience and Remote Sensing 47, 2741–2751.

DeSante, D. F., K. M. Burton, D. Froelich, D. Kaschube, and S. Albert. 2015. MAPS Manual 2015 Protocol: Instructions for the establishment and operation of constant-effort bird-banding stations as part of the monitoring avian productivity and survivorship (MAPS) program. The Institute for Bird Populations, Point Reyes Station, CA.

Dunn, E. H. 2005. Counting migrants to monitor bird populations: State of the art. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191, pp. 712-717.

Dytham, C. 2003. Choosing and Using Statistics: A Biologist's Guide. Blackwell Science, Malde, Massechusetts, USA.

Evans, W. R. 2005. Monitoring night flight calls—the new century ahead. Passenger Pigeon 67:15-29.

Evans W.R., O'Brien M., 2002. Flight Calls of Migratory Birds (Eastern North American Landbirds)[CDROM]. Old Bird. Inc, Ithaca, NY.

Ewert, D.N., G.J. Soulliere, R.D. Macleod, M.C. Shieldcastle, P.G. Rodewald, E. Fujimura, J. Shieldcastle, and R.J. Gates. 2006. Migratory bird stopover site attributes in the western Lake Erie basin. Final report to The George Gund Foundation.

Farnsworth, A. 2005. Flight calls and their value for ornithological and conservation research. Auk 122: 733-746.

Farnsworth, G. L., J. D. Nichols, J. R. Sauer, S. J. Fancy, K. H. Pollock, S. J. Shriner, T. R. Simons. 2005. Statistical approaches to the analysis of point count data: A little extra information can go a long way. USDA Forest Service General Technical Report PSW-GTR-191 pp. 736-743.

Fischer, R. A., S. A. Gauthreaux, Jr., J. J. Valente, M. P. Guilfoyle, and M. D. Kaller. 2012. Comparing transect survey and WSR-88D radar methods for monitoring daily changes in stopover migrant communities. Journal of Field Ornithology 83:61-72.

France, K. E., M. Burger, T. G. Howard, M. D. Schlesinger, K. A. Perkins, M. MacNeil, D. Klein, and D. N. Ewert. 2012. Final report for Lake Ontario Migratory Bird Stopover Project. Prepared by The Nature Conservancy for the New York State Department of Environmental Conservation, in fulfillment of a grant from the New York Great Lakes Protection Fund (C303907).

Gauthreaux, S. A. and C. G. Belser. 1998**.** Displays of bird movements on the WSR-88D: patterns and quantification. Weather and Forecasting 13: 453-464.

Gotelli, N. J. and A. M. Ellison. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, Massachusetts, USA.

Grveles, K.M., S.W. Matteson, S. Eichhorst, and K. Kreitinger. 2011. Protecting Bird Migration Stopover Habitat in the Western Great Lakes: Final Report. Wisconsin Department of Natural Resources Endangered Resources Program.

Harris, J.T. and M.J. Jaeger. 1978. Annotated list of spring birds observed in the Apostle Islands,
1976 and 1977. Passenger Pigeon 40(3):393-405.

Helms, C.W. and W.H. Drury. 1960. Winter and migratory weight and fat field studies on some North American buntings. Bird Banding 31: 1-40.

Holberton, R. L., W. A. Wright, D. F. Bridges, A. J. Leppold, and S. Williams (2012). Using passive acoustic monitoring of migratory flight calls to track spatial and temporal patterns of bird migration in the Gulf of Maine, a complex flyway system. Poster presentation at North American Ornithological Conference, Vancouver B.C.; Canada.

Hussel, D. J. T. and C. J. Ralph. 1998. Recommended methods for monitoring bird populations by counting and capturing migrants. A report by the Intensive Sites Technical Committee of the National Monitoring and Inventory Working Group of Partners in Flight. Available at http://www.fs.fed.us/psw/topics/wildlife/birdmon/pif/migmon.shtml.

Hussel, D. J. T. and C. J. Ralph. 2005. Recommended methods for monitoring bird populations by counting and capturing migrants. North American Bird Bander 90:6-20.

Hutto, R. L., S. M. Pletscet, and P. Hendricks. 1986. A fixed- radius point count method for nonbreeding and breeding season use. Auk 103:593-602.

James, F. C. and H. H. Schugart, Jr. 1970. A quantitative method of habitat description. Audubon Field notes 24:727-736.

Knutson, M. G., N. P. Danz, T. W. Sutherland, and B. R. Gray. 2008. Landbird Monitoring Protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions, Version 1. Biological Monitoring Team Technical Report BMT-2008-01. U.S. Fish and Wildlife Service, La Crosse, WI.

Kreitinger, K. and Paulios, A., editors. 2007. The Wisconsin All-Bird Conservation Plan, Version 1.0. Wisconsin Bird Conservation Initiative, Wisconsin Department of Natural Resources, Madison, WI. Accessed online 8 July 2009: http://www.wisconsinbirds.org/plan

Lambert, J. D., T. P. Hodgman, E. J. Laurent, G. L. Brewer, M. J. Iliff, and R. Dettmers. 2009. *The Northeast Bird Monitoring Handbook.* American Bird Conservancy. The Plains, Virginia. 32 pp.

McDade, L. S., P. G. Rodewald, and K. A. Hatch. 2011. Contribution of emergent aquatic insects to refueling in spring migrant songbirds. Auk 128:127-137.

Mehlman, D.W., S.E. Mabey, D.N. Ewert, C. Duncan, B. Abel, D. Cimprich, R.D. Sutter, and M. Woodrey. 2005. Conserving stopover sites for forest-dwelling migratory landbirds. Auk 122:1281-1290

Mitchell, K. 2007. Quantitative analysis using the point-centered quarter method. Hobart and William Smith Colleges, http://people.hws.edu/mitchell/PCQM.pdf. Accessed 14 June, 2015.

Nur, N., S. L. Jones, and G. R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service, BTP-R6001-1999, Washington, D.C.

Peterson, A. and R. Horton. 2013. Using acoustic and ultrasonic monitors to document bird and bat presence along the Great Lakes coastlines during the 2012 spring and fall migration seasons. Progress report from US Fish and Wildlife Service, US Geological Survey and the University of Minnesota. http://www.fws.gov/radar/documents/Monitors_Report_2012.pdf. Accessed 12 June, 2015.

Pyle, P. 1997. Identification guide to North American birds. Part I. Slate Creek Press, Bolinas, CA.

Ralph, C. J., G.R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA Forest Service Gen. Tech. Rep. PSW-GTR-144, Albany, CA.

Ralph, C. J., S. Droege, and J. R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. USDA Forest Service Gen. Tech. Rep. PSW-GTR-149: 161-169. A. 731 pp.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, NY.

Rodewald, P.G., Brittingham, M.C., 2002. Habitat use and behavior of mixed species landbird flocks during fall migration. The Wilson Bulletin. 114(1): 87-98.

Rodewald, P. G. and M. C. Brittingham. 2004. Stopover habitats of landbirds during fall: use of edge dominated and early successional forests. The Auk 121(4): 1040-1055.

Ruth, J.M., editor. 2007. Applying radar technology to migratory bird conservation and management: strengthening and expanding a collaborative: Fort Collins, Colo., U.S. Geological Survey, Biological Resources Discipline, Open-File Report 2007–1361, 84 p.

Sanders, C. E. and D. J. Mennill. 2014. Acoustic monitoring of nocturnally migrating birds accurately assesses the timing and magnitude of migration through the Great Lakes. Condor 116: 371-383.

Shieldcastle, M.C. 2014. Migrational movements and habitat usage of passerines in the Great Lakes region and specifically the Ottawa National Wildlife Refuge, Ohio. Progress Report-2013. Black Swamp Bird Observatory, BSBO-14-1.

Sillett, T.S. and R.T. Holmes. 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. Journal Animal Ecology 71:296-308.

Smith, R., M. Hamas, M. Dallman and D. Ewert. 1998. Spatial variation in foraging of the Black-throated Green Warbler along the shoreline of northern Lake Huron. Condor 100:474-484.

Smith, R. J. and M. I. Hatch. 2008. A comparison of shrub-dominated and forested habitat use by spring migrating landbirds in northeastern Pennsylvania. Condor 110(4):682-693.

United States Fish and Wildlife Service. 2015. Avian Radar Project. Http://www.fws.gov/radar/index.html . Accessed 7 August 2015.

United States Geological Survey. 2015. Radar technology – a tool for understanding migratory “aerofauna”. Https://www.fort.usgs.gov/radar , accessed 7 August, 2015.

Van Stappen, J.F. and T. C. J. Doolittle. 1993. 1991 migratory bird survey, Apostle Islands National Lakeshore. Passenger Pigeon 55(1):43-49.

Van Stappen, J.F. and T.C.J. Doolittle. 1995. 1993 migratory bird survey – Apostle Islands National Lakeshore. Passenger Pigeon 57(4): 245-253.

WDNR [Wisconsin Department of Natural Resources]. 2005. Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need. Madison, WI.

Appendix A.

Monitoring Our Migratory Birds Workshop
Northern Great Lakes Visitor Center, Ashland, WI
September 18, 2013

Excerpts from the workshop summary including goals, objectives, research needs and questions, and recommended techniques

Workshop Summary

In advance of the Monitoring Our Migratory Birds workshop, participants helped with planning and identified the following workshop goals:

1. Develop a clear understanding among partners of objectives for monitoring migratory birds at various locations along the Lake Superior shoreline.
2. Arrive at an understanding for how best to monitor migratory birds that will inform land management and conservation decisions in order to maximize stopover habitat quality and conserve air space on Lake Superior.

Overarching question:

Is there one or a combination of techniques that will address the above goals?

The workshop consisted of presentations in the morning and working group sessions in the afternoon. The keynote address, titled *Genesis of the Northeast Regional Migration Monitoring Network*, was delivered by Rebecca Holberton, University of Maine. Rebecca described how the Northeast Regional Migration Monitoring Network formed, and the techniques partners have implemented to characterize migration in the Gulf of Maine. Coordination among partners has revealed the following: 1) integrating different methods has filled important gaps; 2) partners are monitoring passerines, shorebirds, and bats; 3) data are sent to a central location and shared across the network; and 4) research can now be connected with conservation actions including habitat management for migratory songbirds, environmental review, and guidance on offshore and coastal wind development.

Anna Peterson, University of Minnesota, presented *Stopover and airspace habitat use in the Lake Superior coastal region*. This is the first study to quantify bird use of a large corridor and the only study covering 2-3 years. Results show that the Lake Superior coastal region is heavily used by migratory birds, which has implications for wind power development along the Great Lakes. We need to understand the cumulative impacts of collisions with structures. Conserving the "migration phenomenon" is important because migration is a critical life stage that has profound effects on survivorship of migratory birds. In the future, recognizing patterns of lake crossing by migrants may lead to a better understanding of key stopover sites along the Lake Superior shore.

In his talk, *Investigating Migration Using Avian Radar Along the Great Lakes*, Nathun Rathbun of the US Fish and Wildlife Service discussed the pros and cons of studying migration with radar. From this Great Lakes study on Lakes Michigan, Huron, Erie, and Ontario, they have learned much about study design, radar unit bias, data analysis methods, and site comparisons (e.g., differences in clutter and other factors). Studying migration with radar: 1) is particularly useful for nocturnal migrants; 2) can provide data that should be useful for siting wind farms; 3) can provide data that may help to protect areas important to migratory birds and bats; 4) can implement procedures to limit collisions of birds and bats with turbines; and 4) can document and visually show migration phenomena (e.g., dawn ascent, flight to shore at dawn, etc.).

Mark Shieldcastle of the Black Swamp Bird Observatory in Ohio presented *Migration Monitoring in the Great Lakes: A Regional Protocol*. Mark described the regional effort to monitor migratory landbirds in the Great Lakes. Goals and objectives include identifying species timing, identifying habitats used and those not used, assessing bird condition, providing management recommendations, and providing public information. The network has a multi-tiered, multi-method protocol that provides flexibility in addressing multiple questions. Proposed protocol levels include master banding stations that operate daily (the hub of the network), periodic banding stations that operate intermittently, and point count locations. These are supplemented with radar and acoustics where possible. Protocol components include standardized minimum protocols: time and detection, mass, fat levels standardized to Helms and Drury (1960), multi-level methods, and dates covering 75% of migration season. Auxiliary marking can help with recaptures and returns. Daily bird list can help with identifying rare species and capturing outside bounds of migration.

Katie Koch's (US Fish and Wildlife Service) talk on *Developing a Midwest Landbird Migration Monitoring Network* provided a smooth transition to the afternoon working session. Katie discussed the components already in place for the Midwest regional network. Components include the Midwest Coordinated Bird Monitoring Partnership, the Midwest Landbird Migration Monitoring Network (see Mark's presentation), and the Midwest Avian Data Center. Katie advised the group to lean on the great network and resources available in Wisconsin. It's important to have a clear question in mind and decisions to inform with the data. Use the Midwest Avian Data Center to explore what species may be using the area of interest or to help with data management and knowledge sharing. With multiple stressors on birds (i.e. diminished habitat, climate, change, predators, etc.), think about how a site can be managed to help birds during this vulnerable part of their life.

In the afternoon, participants formed two working groups to address the identified research needs and to answer the overarching question: Is there one or a combination of techniques that will address the above workshop goals?

Work Assignment

Following a morning plenary session of presentations, participants of the Monitoring Our Migratory Birds Workshop formed two working groups to address five questions (shown below) based on migratory bird research needs identified at the [1]2012 Midwest Bird Conservation Workshop.

We need to measure when, how, where and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles, as well as potential changes in land use as a result of climate change.

2. During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?
3. For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?
4. What tree and shrub species are important to foraging migrant land birds at a particular site, and how do these vary among seasons and within a season?
5. The following question is closely related to the tree and shrub foraging preferences: Relative to the effects of climate change, how are migrant land birds responding to differences in insect and fruit abundance associated with changes in vegetative phenology?

Working Group A was assigned questions 1 and 2, while Group B took questions 3 and 4. Each group had an opportunity to review notes from the other group, and both groups joined for a final review of all notes. Due to time constraints, question 4 was only minimally considered and question 5 was not addressed at the workshop. We asked, however, that comments and recommendations be submitted for questions 4 and 5 in addition to reviewing and adding comments to questions 1-3.

Recommended Protocols

Below is a list of each protocol discussed at the workshop followed by the research or monitoring question addressed by the working group and includes comments relevant to each particular question. For assumptions and caveats, please refer to text.

[1] http://midwestbirdmonitoring.ning.com/group/welandbirdmigration/page/midwest-landbird-migration-monitoring-working-group-notes

Point Counts

Question 1: We need to measure when, how, where and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles. 1a Birds aloft – at risk from towers, etc., 1b Birds below canopy; stopover

- Use for 1b (birds below canopy/stopover)
- could inform 1a, particularly for modeling

Question 2: During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?

- Use to identify where to place banding station(s) and address other questions
- Set up an array of point counts and consider deploying acoustic arrays at some locations (see acoustic monitoring)
- Island vs. Mainland: on mainland use point counts in conjunction with radar and acoustic monitoring
- Coastline vs. non-coastline
- Riparian vs. non-riparian, riparian perpendicular to coastline, wetland
- Compare land cover types
- We need a layered approach that works at these varying scales (see also radar and acoustic monitoring)

Question 3: For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?

- Multiple point counts for rest of strata (not being sampled by banding or acoustic monitoring). Use pilot study to determine variability which will determine number of points per strata.
- Apostle Islands – for strata difficult to sample use acoustic monitoring in place or point counts or sample less point counts and camp pout in one area for an extended period (e.g., south end of Outer Island
- How many point counts are needed? Engage a statistician!!! This depends on the scale of the questions being asked.

Banding

Question 1: We need to measure when, how, where and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles. 1a Birds aloft – at risk from towers, etc., 1b Birds below canopy; stopover

- Banding station – blood/feather sampling for condition
- Standardize evaluation of fat levels (Helms and Drury 1960)
- Applicable for 1b
- Could inform 1a, particularly for modeling

Question 2: During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?

- Engage Hawk Ridge Bird Observatory, Wisconsin DNR, UMD, NERR (Superior, WI), NRRI and, Northland College in banding efforts

Question 3: For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?

- One master station run every day during migration (perhaps on Bayfield peninsula)
- Estimate cost for a fall season at under $15,000 (this figure would go down if we had housing provided and shared equipment)
- To assess habitat quality use fat stores on recaptures in combination with metabolite studies (and/or telemetry or other tracking)

Question 4: What tree, shrub and grassland species are important to foraging migrant land birds at a particular site?

- To assess habitat quality use fat stores on recaptures in combination with metabolite studies (and/or telemetry or other tracking)

Acoustic Monitoring

Question 1: We need to measure when, how, where and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles. 1a Birds aloft – at risk from towers, etc., 1b Birds below canopy; stopover

- ½ hour after sunset to three hours after sunrise – 1a and 1b
- Set up permanent stations for long term monitoring (start small and add)
- Can use as a tool to evaluate whether to put a project (wind power/communication tower) in a specific area
- Useful to survey for difficult to detect species and monitoring species that migrate at night
- Helps answer when migrating is occurring, relative volume
- Monitors changes in timing of flights and composition of flocks

Question 2: During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?

- Island vs. mainland – put acoustic (and radar) units on smaller islands; also useful on mainland with point counts and radar
- to identify where to place banding stations – consider deploying acoustic arrays at some locations in addition to point counts
- set up three acoustic arrays at locations where we don't have other efforts or can't send people to on a regular basis (e.g., Apostle Islands)
- move the acoustic units around to help increase coverage and get basic information about relative movements of birds across the region (may be akin to a fishing expedition)

Question 3: For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?

- Apostle Islands - acoustics could be useful for strata that are difficult to sample

Radar

Question 1: We need to measure when, how, where and in what condition concentrations of migrant birds move through the Lake Superior basin (particularly along riparian corridors, ridges, and at river/stream mouths) so that we may effectively address conservation challenges posed by proposed wind farms, communication towers, buildings, and other developmental migratory obstacles. 1a Birds aloft – at risk from towers, etc., 1b Birds below canopy; stopover

- Useful for 1a and 1b
- Engage Great Lakes steamer's radar for data on migrating birds across the lake

Question 2: During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?

- Island vs. mainland: put radar (and acoustic) units on smaller islands and also use on mainland with point counts and acoustics

Question 3: For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?

- Use marine radar to test the recommended 3-mile buffer in voluntary guidelines ("coastal effect") along the Wisconsin shore of Lake Superior (pattern after work on Lake Michigan)
- Use a mobile radar unit to test assumptions/validate patterns to fill gaps from banding and point counts

Other Considerations

Question 2: During spring and fall migration, what habitats at a particular site are most important (habitats most used based on number of species and abundance)?

- Use eBird and Midwest Avian Data Center data to provide an index of temporal patterns for most species
- Identify a coordinator for this effort
- Put on training workshops to ensure proper method use and standardization

Question 3: For a particular site, how do land bird assemblages vary among habitats, within a season and among seasons?

- Determine what habitats do we have to work with
- Clarify how far south within the Lake Superior basin should monitoring occur. Use WDNR Lake Superior Coastal Plain as the study area.
- Include captain's records of where birds are crossing the lake. The corresponding points on shore may be important places to monitor
- Coordinate with other Great Lakes monitoring efforts so we are standardized in techniques

Appendix B. Common and scientific names of birds mentioned in this document

Common Name	Scientific Name
Upland Sandpiper	*Bartramia longicauda*
American Woodcock	*Scolopax minor*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Eastern Whip-poor-will	*Antrostomus vociferus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Olive-sided Flycatcher	*Contopus cooperi*
Least Flycatcher	*Empidonax minimus*
Veery	*Catharus Fuscescens*
Wood Thrush	*Hylocichla mustelina*
Swainson's Thrush	*Catharus ustulatus*
Brown Thrasher	*Toxostoma rufum*
Golden-winged Warbler	*Vermivora chrisoptera*
Black-throated Blue Warbler	*Setophaga caerulescens*
Connecticut Warbler	*Oporornis agilis*
Canada Warbler	*Cardellina canadensis*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*pooecetes gramineus*
Le Conte's Sparrow	*Ammodramus leconteii*
Dickcissel	*Spiza Americana*
Bobolink	*Aolichonyx oryzivorous*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Rusty Blackbird	*Euphagus carolinus*

Appendix C. Point count data sheet example

NHI Migratory Bird Survey Data Sheet – Lake Superior Basin

Date *(month, day, year)*: 5/10/15

Pg 1 of 1

Site # and Name: #1 Brule SE

Observer: Jane Smith

Survey replication #: 1

	Before	After
Temperature (°F):	50	
Wind speed *(see below)*:	1	
Cloud cover *(%)*:	75	
Precipitation *(see below)*:	none	

Point #	Start Time (military)	Background Noise	Species	Gender (m, f, u)	Minute	Detection Type(s)	Comments
1	06:30	0	OVEN	M	0-3	A	
			BLJA	u	"	B	
			BLJA	u		B	
			YEWA	M	"	A	
			COYE	M	"	A	
			AMRO	M	"	B	
			NAWA	M	"	A	
			BAWW	M	"	B	
			PIWO	M	"	F	
			COYE	F	"	V	
			OVEN	M	"	A	
			AMRE	M	4-5	B	
			WIWR	M	"	A	
			BTNW	M	"	A	
			DOWO	F	"	V	
			DOWO	M	"	V	
			AMRE	M	"	A	
			HETH	M	6-10	A	
			CMWA	M	"	A	
			TRES	U	"	F	

Focal Species: see list in survey protocol

Minute: Minute 1-3, Minute 4-5, Minute 6-10

Detection Type(s): Visual (V), Auditory (A), Both (B), Flyover (F)

Comments: note behaviors and habitat associations, if possible, foraging (f), canopy (c), sub-canopy (u), shrub (s), ground (g), marsh (m)

Beaufort Wind Scale: Do not survey if wind speed is above 5 on scale (see back)

Precipitation: light rain, rain, heavy rain, light snow, snow, heavy snow, fog, none

Background noise: 0 no noise 1 faint noise 2 moderate noise *(probably can't hear some birds beyond 100m)*
3 loud noise *(probably can't hear some birds beyond 50m)* 4 intense noise *(probably can't hear some birds beyond 25m)*

Appendix D. Bird Identification Training Resources

Electronic resources

The University of Wisconsin, Green Bay has developed a Birder Certification Program http://www.birdercertification.org/ for the western Great Lakes Region (Bird Conservation Regions [BCR] 12 and 23). This website allows bird observers to certify their skills in identifying birds by sight and sound. It contains instructional materials, links to online quizzes, and visual and auditory practice tests in addition to the certification tests.

Birding Skills from Cornell Lab of Ornithology:
http://www.allaboutbirds.org/page.aspx?pid=1053

Birding 1,2,3 bird ID quizzes from Cornell Lab of Ornithology:
http://www.birds.cornell.edu/AllAboutBirds/birding123/identify/quiz

Online course from Cornell Lab of Ornithology: http://www.birds.cornell.edu/courses/home/
Tutorials, webinars, and home study courses

Field Guides (alphabetical order)

A Field Guide to the Birds of Eastern and Central North America by Roger Tory Peterson and Virginia Marie Peterson.

Peterson Field Guide to Birds of North America by Roger Tory Peterson

Kaufman Field Guide to Birds of North America by Kenn Kaufman.

National Audubon Society Field Guide to North American Birds: Eastern Region by National Audubon Society.

National Geographic Field Guide to the Birds of North America by Dunn and Alderfer.

National Wildlife Federation Field Guide to Birds of North America by Edward Brinkley.

The Sibley Field Guide to Birds of Eastern North America by David Allen Sibley.

The Sibley Guide to Birds by David Allen Sibley.

Stokes Field Guide to Birds Eastern Region by Donald and Lillian Stokes.

This list of field guides and reviews of each may be found at
http://www.wildlifesouth.com/Birding/BirdingFieldGuideReviews.html

Smartphone Apps

Audubon Birds Pro by National Audubon Society
https://itunes.apple.com/us/app/audubon-birds/id333227386?mt=8&ign-mpt=uo%3D4

iBird Pro Guide to Birds by Mitch Waite Group
https://itunes.apple.com/us/app/ibird-pro-guide-to-birds/id308018823?mt=8&ign-mpt=uo%3D4

Merlin Bird ID by Cornell Lab of Ornithology
https://itunes.apple.com/us/app/merlin-bird-id-by-cornell/id773457673?mt=8

National Geographic Birds: Field Guide to North America by National Geographic Society
https://itunes.apple.com/us/app/national-geographic-birds/id315268465?mt=8&ign-mpt=uo%3D4

Peterson Birds — A Field Guide to Birds of North America by gWhiz LLC
https://itunes.apple.com/us/app/peterson-birds-field-guide/id407825684?mt=8&ign-mpt=uo%3D4

The Sibley eGuide to the Birds of North America by mydigitalearth.com
https://itunes.apple.com/us/app/sibley-eguide-to-birds-north/id354101483?mt=8&ign-mpt=uo%3D4

Appendix E. Rapid vegetation assessment procedure (Knutson et al. 2008)

This protocol is used by the University of Minnesota Natural Resources Research Institute for bird point counts in forested landscapes. The objective of this vegetation sampling method is to get information on habitat structure and plant composition as quickly and as accurately as possible while conducting a bird survey. With some experience and familiarity with the trees and shrubs of the region, vegetation data can be gathered in less than 3 minutes after the bird survey.

1. Canopy Height – The average canopy height (in meters) within the 100 m radius should be estimated. This does not include shrub or subcanopy layers. Note: If the point is in a new clear-cut with residual trees, estimate canopy height for the residual trees. If the point is in a regenerating aspen stand with DBH greater than 2.5 cm, estimate the canopy height of the regenerating aspen. If the regenerating aspen is less than 2.5 cm DBH, estimate the canopy height of the residual trees. Be sure to include code 9, 10, or 11 under Special Features.

2. Tree Density – Estimate tree density by counting all the trees (> 2.5 cm DBH) within a 10 m radius and assigning the corresponding density code by abundance.

TREE DENSITY (> 2.5 CM DBH)	
1	None
2	<5 in 10m radius
3	6 to 20
4	21 to 40
5	>40

3. Shrub Density – Estimate shrub density in the same manner as above except count those woody plants with a DBH of 2.5 cm or less within a 10 m radius.

SHRUB DENSITY (< 2.5 CM DBH)	
1	<10 in 10m radius
2	11 to 100
3	101 to 500
4	501 to 1000
5	>1000

4. High Canopy Cover – Estimate the percent coverage of the high canopy layer within the 100 m radius, using percent estimated in increments of 10.

5. High Canopy % Deciduous – Estimate the percent of deciduous species found within the high canopy, using percent estimated in increments of 10.

6. Subcanopy Cover – Estimate the percent coverage of the subcanopy layer within the 100 m radius, using percent estimated in increments of 10.

7. Subcanopy % Deciduous – Estimate the percent of deciduous species found within the subcanopy, using percent estimated in increments of 10.

8. Understory Cover – Estimate the percent coverage of the understory layer within the 100 m radius, using percent estimated in increments of 10.

9. Understory % Deciduous – Estimate the percent of deciduous species found within the understory, using percent estimated in increments of 10.

10. Ground Cover - Estimate the percent coverage of the ground layer within the 100 m radius, using percent estimated in increments of 10.

11. Tree Species – List up to five tree species (> 2.5 cm DBH), beginning with the most abundant species.

12. Shrub Species – List up to five shrub species (< 2.5 cm DBH; this can include tree species), beginning with the most abundant species.

13. Special Features – List up to three special features (see code sheet). <u>Note</u>: Special feature 9, 10, or 11 should be used when residual trees are found within the 100 m radius.

SPECIAL FEATURES		
1 Beaver flooding	7	Natural opening in site
2 Large downed logs	8	Rock outcrop
3 Small openings	9	Residual hardwood trees
4 Snags	10	Residual conifer trees
5 Wetland pocket in site	11	Residual patches
6 Woodland pond in site	12	Roads, buildings

Appendix F. Point-centered quarter vegetation form (Mitchell 2007)

***PRBO* Point-Centered Quarter Vegetation Form 1999**

Initials:_______State:________Region:___________Site:_________Date:_______

Point #:________ Aspect:_________ ° Slope:_________

Notes:____

____

____

Closest Shrub measurements at a 100 meter radius.				
	Q1	**Q2**	**Q3**	**Q4**
Species				
Dist to shrub (m)				
Ht. of shrub (m)				
Max. shrub width (m)				
Width perp. to max. (m)				

Closest Living Tree measurements at a 100 meter radius.				
	Q1	**Q2**	**Q3**	**Q4**
Species				
Dist. to tree (m)				
Ht. of tree (m)				
DBH (cm)				
Av. crown width (m)				
Canopy cov. (densi.)				

Closest Snag ($\geq$12 cm dbh) measurements at a 25 meter radius.				
	Q1	**Q2**	**Q3**	**Q4**
Dist. to snag (m)				
Ht. of snag (m)				
Av. crown width (m)				
DBH (cm)				
Canopy cov. (densi.)				