LANDBIRD MIGRATION BANDING INITIATIVE
Midwest Coordinated Bird Monitoring Partnership
2017 Protocol
Version 09/18

ACKNOWLEDGEMENTS

Development of a standardized migration network has lagged behind similar efforts for the breeding and wintering portions of the avian life cycle. With the plans for development of full life cycle models for landbirds, the USFWS and North American Bird Conservation Initiative (NABCI) have recognized the importance of migration and stopover habitat to the conservation of birds. While discussions of a coordinated migration program have been ongoing for nearly two decades, little advancement has been accomplished. It is with this goal that the Midwest Migration Network (MMN) has been established. The leadership demonstrated by the developers of Monitoring Avian Production and Survivorship (MAPS) and the Monitoreo de Sobrevivencia Invernal (MoSI) programs cannot be understated as this migration network moves forward. The foresight demonstrated by David DeSante and his colleagues at the Institute for Bird Populations (IBP) have mapped out a proven system to bird monitoring with the creation of the extremely well-designed manual for MAPS, a model extensively utilized to format this MMN manual. By following the lead of MAPS, we hope to simplify field operations for the individual bander by using familiar techniques. The role of the NABCI Monitoring Committee has been invaluable in providing direction for populating the full life cycle models that will lead bird conservation into the future. The Bird Banding Laboratory (BBL) has been indispensible as a resource offering guidance in discussing objectives and cost of the development of a systematic approach to migration banding. Finally, the development and the future success of an expansive endeavor such as a migration network is not possible without the huge numbers of volunteer banders, extractors, and counters who work across the landscape making a program that no one organization or agency could ever hope to finance.

INTRODUCTION

Welcome to the Midwest Migration Network. The development of this network is a cooperative effort of many public agencies, non-government organizations, and universities in the Great Lakes and Upper Mississippi River region. The initiative's goals and objectives include:

1- Development of a long-term multi-level monitoring program for landbirds during migration;
2- Standardization of avian migration banding and point count protocols and data collection;
3- Development of a network of cooperators; and
4- Filling important knowledge gaps in existing programs such as MAPS and MoSI for informing the full life cycle models of landbirds in North America.

Multi-level data collection will allow for the greatest participation and land coverage. Data collection standardization will be of utmost importance for long-term analysis but must be flexible for the variety of habitats and opportunities across the target region.

The MMN is dedicated to working with you in an effort to monitor migrational parameters of North American landbirds. This manual is designed to guide you through the steps of gathering systematic migration data and to address any questions that may arise. A standardized methodology for mist-netting and bird banding during migration will address both landscape and local scale questions related to avian population parameters, habitat use, and connectivity. This methodology can provide annual indices of population size, fall age ratios for productivity, spring age ratios for winter survival and migrational mortality, recruitment into adult populations, and understanding connectivity between breeding, wintering, and migrational stopover habitat to discern distinct populations. Portions of these data will be useful by researchers developing the full life cycle models for multiple landbird species.

Any private organization, individual bander, or public agency operating a migration banding station or conducting systematic point count routes may be part of this endeavor. Requirements of this standardization of data collecting criteria are covered later in this manual. This is meant to be a flexible network accepting a variety of levels of participation to allow for the inclusion of existing field operations as well as setting a standard for new operations in the region. Similar to the Breeding Bird Survey (BBS) and MAPS standardization, station longevity will be vital to obtaining reliable information for parameters required for full life cycle models and addressing many management questions linked to important conservation issues facing migratory birds.

We invite you to join in the Midwest Migration Network. How to become involved in this initiative will be covered throughout this manual. The methodology covered below may seem complicated at first read. However, it involves four simple concepts:

1- Standardized mist netting and banding during the spring/fall migration seasons,
2- Simple habitat map and habitat structure assessment,
3- Standardized point counts, and
4- Daily list.

MMN cooperators will provide you with technical assistance, training and guidance year-round. While there will be important criteria that must be complied with for analytical needs, the MMN is flexible in timing, field effort, and extraneous data collection needs and can also support past data collections in some instances. We invite you to participate in this new endeavor to close the gaps in knowledge of the full life cycles of landbirds in North America.

BIRD SAFETY

The protocols and objectives covered in the following pages are designed to collect data that have value for bird conservation. **Bird safety begins with your study design (protocols), not with the beginning of field data collection.** However, protocols should never be followed at the expense of bird or human safety. As a responsible bander, if safety is ever a concern, you should suspend protocols until the concerns are addressed. Please ensure that all of the banders at your station know and practice safe banding techniques and adhere to North American Banding Council (NABC) code of ethics (http://www.nabanding.net/banders-code-of-ethics/). Protocol review by an Institutional Animal Care and Use Committee may also be necessary for certain projects and affiliates.

Ethical banding and safety protocol review should be a constant procedure with your crew while always striving towards a safer banding experience. We recommend reviewing materials such as those provided by the NABC (www.nabanding.net) and The Ornithological Council (*Guidelines to the Use of Wild Birds in Research*; http://www.nmnh.si.edu/BIRDNET/guide/index.html.

PROPER PERMITTING

All banders operating banding stations must adhere to all federal and state permitting requirements and provisions under the Migratory Bird Treaty Act (MBTA). See the Bird Banding Laboratory website for details on the permitting process (https://www.usgs.gov/centers/pwrc/science/general-permit-information?qt-science_center_objects=0#qt-science_center_objects). Study site permits may be required for certain land ownerships. Check to assure that relevant permits are up-to-date. As part of MMN, there may be requests from individual researchers for the collection of feathers or application of auxiliary markers for various studies addressing species or population connectivity or other specific questions. Authorization is required on a federal banding permit to allow a permittee or sub-permittee to pull feathers or use an auxiliary marker on an individual bird either by you or the requesting researcher. If a permittee intends to do either of these activities and are not already authorized, they must contact their Federal permitting agency (BBL in the US or BBO in Canada) to apply for authorization. Requests coming from outside researchers will come with their own protocols and materials for accomplishing the field work. Sample collection involving tissues other than blood or feathers will require a Federal Migratory Bird Scientific Collecting Permit from the US FWS. Shipment of samples may require additional permits (e.g., a US FWS export permit to ship samples to another country).

BACKGROUND AND RATIONALE

Landbird populations are facing an ever-increasing number of environmental threats throughout their life cycles. While many are local or regional threats, some reach the global scale, including climate change, habitat loss, invasive species displacement, and toxic pollution (Brown 1991, National Audubon Society 2015, North American Bird Conservation Initiative- U.S. Committee 2015). Several broad-scale surveys were enacted to begin to understand these threats. They have been centered on breeding and wintering periods of the life cycle and include the Christmas Bird Count, Mid-winter Waterfowl Survey, Breeding Bird Census, Breeding Waterfowl Surveys, and the North American Breeding Bird Survey. These efforts indicated population declines in many Neotropical migrant songbird species (Robbins *et al*. 1989, Terborgh 1989, Knopf 1994). In 1989, the MAPS program was initiated by The Institute for Bird Populations (IBP). It represented the first study design to collect standardized data on primary demographics or vital rates (productivity and survivorship) of landbirds (DeSante *et al.* 2016). This innovative program was followed in 2002 with the development of a systematic wintering banding program known as Monitoreo De Sobrevivencia Interval (MoSI) (DeSante *et al.* 2005). These two programs were created to acquire data needed to understand the effect of birth rates and death rates on population changes of migrant species (DeSante 1992). As stated in DeSante *et al.* (2016), "efforts that monitor only avian population trends have generally been unable to determine to what extent habitat destruction and degradation (e.g. deforestation and forest fragmentation) on the temperate breeding grounds, versus that on the tropical wintering grounds, are causes for

declining populations of neotropical migratory landbirds" (Wilcove 1985, Holmes and Sherry 1988, Hutto 1988, Morton and Greenberg 1989, Peterjohn *et al*. 1995).

In an attempt to identify and address declining population trends, it is important to establish primary demographic parameters to populate the increasingly complex full life cycle models now being designed. This is highlighted in the rationale section of the MAPS manual (DeSante et al. 2016) by this quote

> "An integrated approach to monitoring primary demographic parameters and secondary population trends of landbirds is critical for determining causes of population changes and for identifying management actions and conservation strategies to reverse population declines (Baillie 1990). Perhaps more importantly, this approach aids in evaluating the effectiveness of on the ground management and conservation strategies (DeSante 1995). Environmental stressors and management actions affect primary demographic parameters directly often without the buffering or time lags that often occur with secondary population trends (Temple and Wiens 1989). Monitoring the vital rates of landbirds allows models to be constructed regarding the viability of their populations. Habitat- and landscape-specific data on vital rates provide a clear index of habitat and landscape quality, and allow identification of habitat and landscape conditions that indicate source populations and influence population sinks (DeSante and Rosenberg 1998). An increase in demographic monitoring has been called for by the Monitoring Working Group of Partners in Flight (PIF) since 1992 (Butcher and Droege 1992), and an argument for basing avian management on vital rates has been provided by DeSante *et al*. (2005)".

Because full life cycle models are forced to determine species population trends with data gaps for portions of the life cycle not represented, the interest in developing a systematic, coordinated migration protocol has been considered to include the rest of the annual cycle. For some species, migration may actually be the major contributor to population declines (Sillett and Holmes 2002). In recent meetings of the North American Bird Conservation Initiative Monitoring Committee, discussions have recognized that at least some of the vital parameters, especially first year survival, are not being accurately represented from MAPS and MoSi data. With increasing threats in the Great Lakes region, including habitat loss and fragmentation, proliferation of aerial structures into the air column, and loss of critical stopover habitat, the MMN has been formed to develop, a regional network of cooperators to gather comparable data sets to close regional information gaps. Fall migration monitoring may be able to develop better indices of productivity at the species and population-level as has been achieved with waterfowl models, and to provide similar primary demographic parameters in spring migration that can further inform full life cycle models on winter mortality, migration mortality, survivorship, and recruitment. The MMN is being established to address these lofty goals, to inform conservation efforts, protect and enhance habitat, and to supplement breeding and wintering data.

A standardized network provides broad advantages to both data contributors and researchers. For **Contributors** (eg. banding stations, Audubon chapters, bird clubs, park systems, agencies, Academia), the MMN provides:

- An opportunity to participate in big-picture questions on a regional or greater scale;

- A systematic protocol with which to collect data elevating its value for cooperative projects and programs. Data becomes useful beyond personnel use;
- Data access capabilities through the Midwest Data Center, managed by the USFWS;
- Guidance on sample design issues; and
- Enhanced conservation work as a result of their field data collection efforts. Cooperators can see their research applied to real world conservation efforts.

For **Researchers** (includes Cooperators and researchers needing field data for study questions beyond their physical resources), the MMN:

- For small scale questions, can provide potential cooperators in the area of interest that are already doing field work and may be able to supply field assistance;
- For large scale questions, provides a field station database to help facilitate collaboration;
- Provides clear sample design techniques of contributors in the network for review by any researcher to evaluate if data is being collected in a compatible method for their project question; and
- Provides geographic context to existing capacity of ongoing field work.

DESIGN AND OBJECTIVES OF THE MMN PROGRAM

As challenges and stressors continue to increase on migratory birds, it is imperative that we have adequate information on which to base sound management decisions. Recent meetings of the North American Bird Conservation Initiative Monitoring Committee have stressed the need to develop full life cycle models for landbirds. Emphasis was placed on using knowledge garnered from successfully established waterfowl models as templates to progress landbird conservation into the future. A series of important parameters are needed to inform these models to guide the initiative. Parameters include: age structure of species and populations, productivity, recruitment, survival, and connectivity between various portions of the life cycle. Components of productivity, age structure, and survival are acquired through migration surveys for the waterfowl models. It is of a primary importance in the formation of the MMN to collect data that inform these valued parameters.

Many species of landbirds nest in unobservable climates and habitats. A sound scientific migration monitoring program of large geographic scale will provide a means to index, survey, and evaluate landbird populations with regards to population level, trend, energetic condition, and breeding success. This program would be compatible to Breeding Bird Survey and MAPS by developing population models for individual species and guilds. Before determining to what extent these models can be developed, data need to be gathered in a systematic manner to develop a sound database from which to work.

It is a high priority of the MMN to build a team of field collaborators who can work together on big picture questions facing migratory birds. Collaborators can also provide field expertise for researchers needing assistance in acquiring avian samples for feather collection, auxiliary marking, and other methodologies such as radar and telemetry surveillance.

The MMN, based in the Great Lakes/ Upper Mississippi River region, will focus on banding stations and systematic point count programs. Standardization of data collection is of utmost importance for addressing regional and national conservation issues. It is the goal of the MMN to remain flexible in field operations yet also require certain standards be met. The multi-level data collection is designed to be as inclusive as possible while still adhering to vital standardization requirements. These data will include specific banding data, field station effort data, habitat data, and observation survey data; and be housed in the Midwest Avian Data Center (a node of the Avian Knowledge Network) or Bird Banding Laboratory. They will be available for a variety of cooperator and researcher uses. An important part of the MMN will be to develop and deliver comprehensive training opportunities to banders throughout the region in keeping with the legal requirements of banding, field techniques, and safe and efficient methodologies.

The use of multi-level data collection techniques should improve predictive accuracy of demographic rates and abundance across space and time. Identification of long-term and short-term spatial and temporal variations in migration will strengthen the full life cycle models and inform management and conservation. This can only improve stopover habitat management and provide information in range-wide issues such as wind power and other air column habitat concerns. The MMN will inform the identification of distinct populations, the role of weather in migration, and identify connectivity between breeding, wintering, and stopover habitats throughout the full life cycle.

The MMN will provide a scientific basis for individual field operations and provide justification to regulators such as the BBL for migration banding. By identifying specific objectives, the MMN will serve as the standard for migration banding analogous to the MAPS program for breeding studies and will assist the BBL staff on material needs for future years.

In short, the objectives of the MMN will complement standardized breeding and wintering programs in identifying and describing spatial and temporal patterns in demographic parameters; relating these to species-specific population trends and life history strategies, habitat characteristics, and weather variables; and using the resulting relationships to formulate management strategies for reversing population declines.

As essential as they are, individual stations are unable to adequately sample the vast landbird populations and account for atmospheric variations, geographic variations, and annual variations inherent to migration studies. However, en masse, migrational timing, lipid storage, weather-induced variation, as well as population parameters, will be able to be analyzed for effects on population trends.

ANALYTICAL USES OF MMN DATA

The assessment and monitoring of avian vital rates using MMN may well provide one of the optimal resources with which to model and predict among many threats the effects of climate change on landbird populations, to guide adaptation and conservation efforts to mitigate those effects, and to evaluate the effectiveness of those efforts. Standardized databases have become critically important as state and federal agencies and non-governmental organizations seek to develop bird conservation plans to deal with the huge threats posed by climate change.

The MMN will bring collaborators, researchers, and various data streams together and provide the basis for as many pertinent questions as possible in the shortest time frame possible. Questions may come from local, state, regional, national, or international levels spatially or temporally as well as Bird Conservation Regions, Joint Ventures, and the like. They could be agency regulatory responsibility driven, NGO sponsored, or from environmental concerns on industrial development. Questions may be as broad as life cycle in nature, at the distinct population level, or at a local habitat-scale. The MMN is designed to provide cooperators and their individual data contributions at all levels. Individual researchers may need to design sample effort augmentation depending on the question, but they will have the first few steps in place via the MMN cooperators.

The MMN can provide the framework for understanding or defining connectivity among breeding, migration, and wintering habitats by contributing the samples to telemetry and isotope studies. The importance of demographic monitoring and the value of the MMN Program increases annually as the network and dataset grow. The potential to combine this standardized migration data with the existing MAPS and MoSI programs will increase the power of the data in addressing spatial and temporal questions vital to bird conservation.

ESTABLISHMENT AND GENERAL OPERATION OF MMN STATIONS

While the MMN is designed to enroll existing programs into a standardized data collection process, it will welcome potential new sites willing to meet the standardization and continuity requirements. This section provides the guidance needed for existing stations, as well as for those interested in initiating field operations with the MMN. The following guidelines for the establishment and operation of MMN stations will optimize usefulness of data being collected across the Midwest region. Standardization, communication, and continuity are critical components of the MMN Program. Existing stations will be reviewed for differences in protocol from the MMN and potential changes or adjustment options suggested. For new stations, the first year is considered a pilot year, as station protocols are reviewed for meeting objectives of that site. Station boundaries and net sites may be shifted during or after the first field season if necessary. Any such changes must be documented and reported, and no further changes ought to be made after the start of the second field season. If net sites are changed, new net designations must differ from those of the discontinued sites.

Standardization in station operations from year-to-year is critical for regional and continental questions related to bird conservation. Station continuity is also important for minimizing population-parameter fluctuations that may result from year-to-year changes in the geographic distribution of birds. Because of variation in weather and other uncontrollable factors, we recognize that no station can achieve perfect standardization effort within a given season, but it is important that the following guidelines be adhered to as closely as possible within and between seasons.

The MMN program’s strong suit is the standardization of migrational data collection applicable to a wide variety of research and monitoring questions. While many of these questions will require the handling of birds, some questions can be informed by observational techniques as

long as standardization exists among sites. This program is designed to be flexible and allow for localized questions, but it does have a number of protocols that must be adhered to for regional use. The MMN provides a series of participation levels, all of which can provide important contributions to regional questions being addressed. The program methodology will consist of two levels of intensive monitoring, with a third more extensive level of point count areas only. All stations should strive to collect data throughout at least 75% of the migration season; spring (March – June) and fall (August - November) with equal non-sampled portions allocated between beginning and ending of each migratory period. Several layers of data will be collected at each of the two higher station levels. These will range from the most qualitative, banding, to point counts and to daily list, the most quantitative. These will be discussed in depth in individual sections below.

LEVEL – 1 – Master Station

Level 1 participation will consist of those stations that can conduct banding operations daily throughout the migration time periods. These "Master Stations" will take on the added importance of acting as control sites for level 2 and 3 stations. In addition to banding, the station will conduct daily point counts and compile a daily species list. Each of these methods will be discussed in detail below.

LEVEL – 2 – Periodic Station

The Level 2 stations will conduct operations in the same manner as Level 1 stations with the exception that the station is not operated on a daily basis. There are no restrictions on which days the station is run other than the attempt to standardize season start and end dates. This may not always be possible, and deviation must be noted in the station metadata. Examples of operation can be standardized (i.e. same days of the week throughout the season), when personnel are available, or for a short portion of the migration season (2 weeks every day). Each of these can be accommodated as long as data collection protocols are followed.

LEVEL – 3 – Observation Stations

There will be organizations or individuals that do not have the ability to conduct banding operations, either due to lack of banding expertise or use restrictions on a given track of land, but they can still conduct point counts and the daily list. These observation stations conduct a standardized point count and compile a daily list the same as for Level 1 and 2 on a designated station. This can occur daily or whenever available (systematic or random) during the migratory periods.

These three levels provide flexibility for individual research and monitoring projects and the maximum participation. The greater the land coverage of data points, the better we can address landscape level questions. Sample design questions can be addressed over time to better quantify geographic coverage to obtain critical model information.

What To Count

Stations will strive to meet minimum requirements at their participating level. Banding methodology of Level 1 and 2 stations should attempt to tally newly arrived migrants, residents, and stopover migrants banded on earlier days as described later in the methodology section. In simplest terms, point counts and lists are to record everything seen or heard during the day's activities. Level 3 stations will fill holes in coverage where banding expertise may not exist or land regulations preclude bird capture. This systematic long-term data sets will have the greatest value in many of the questions facing today's avifauna.

Regional data analysis is only possible with standardized data collection. While some questions will have concerns on interpretation, it is the goal of the MMN to provide adequate information in study design to include or exclude data points as needed. No matter how much effort is put into development of a good study design, there will be decisions to make on what to include or not to include by individual researchers. An example would be identification of individuals of a species that is a migrant for the site but contains individuals that are on summer or winter territories. Recaptures collected will be useful as this data variable is investigated for analysis affects (Kelley 1991). Year around residents of non-migratory species or non target species are of less concern as they will be easily separated for analysis from migrants if desired by the researcher. The identification each day of new bandings, recaptures, returns, time of banding, and individual demographics will provide for a variety of analysis and allow direct comparisons between sites.

Siting a MMN Station

It is the desire of the MMN to coordinate with cooperators representing a wide geographic distribution in the Midwest region. It is also a desire to include as much historical data as possible into the dataset to provide for a broader time frame for analysis of the many questions the MMN can address. With this concept in mind, it is the goal to try and involve as many established stations as possible. However, this is not meant to discourage new stations from initiating data collection.

The guidelines for a migration site are in many ways very different from a breeding site. Habitat requirements are very different between the two life cycle time frames, and bird behavior is quite distinct in many ways as well. A useful migration site may have little value as a breeding site, and the station development thought process must keep this in mind. Station development should be based on stopover values first. A wide variety of habitats within the landscape will most likely be needed to capture even simple demographics such as population age ratios. As the Landbird Migration Banding Initiative becomes established, it will begin to identify geographic gaps, habitat differences, biological idiosyncrasies, and landscape nuances that may need to be addressed to improve understanding of this life cycle time frame.

Detailed maps and geographic location of the study site is a must for continental data analysis. Sites should represent concentration points for migrants but will not be held as a strict requirement for participation. Multiple sites in a single area will improve local data but can be costly. Sites are recommended to be 5 - 20 ha in size and to contain adequate natural edge for

nets and count locations. Sites should be protected from development and disturbance for long-term continuity and any potential concerns documented. Site maps should show habitat type, management options, potential habitat changes, ownership, net sites, and point count locations. It is recommended each station has a management plan to refer to over time.

With these concepts in mind, the following guidelines for siting stations should be considered both by existing operations (how do these fit in the existing program) and new station development:
(1) The establishment of a station should be done within the context of the surrounding landscape. Since bird captures will be random this selection can be opportunistic or couched in a probabilistic sampling strategy. Specific research questions at the local level may dictate the sample location.
(2) Considering the need for long-term datasets, stations should be established at sites that are expected to remain accessible and free of major anthropogenic disturbance for multiple (preferably twenty) consecutive years. While not ideal, there can be disturbance, even heavy disturbance, in the surrounding landscape. If there is disturbance at the station (or in the landscape), it should be described through the Habitat Structure Assessment (page 18).
(3) Stations should be sited where substantial numbers of individuals of many of the MMN targeted species (see Appendix 1) are migrating through the area.
(4) The habitat types at the station should be fairly representative of those present in the surrounding landscape.
(5) In order to ensure standardization, MMN stations may not incorporate any artificial food or water sources such as feeders, compost piles, dumps, birdbaths, fountains, and livestock pens. Audio playback calls should not be used.

Establishing a MMN Station

MMN TERMINOLOGY: A MMN – "Station" is a discrete study area consisting of a number of net sites ("nets," the exact places at which nets are located) and/or point count sites. Each station operator provides a station name. Upon receipt of a station's application a nine-digit station number consisting of the state's three digit BBL code and a unique numeric code (ex. MMN266-001) will be assigned. This code will be included in all datasets sent to the Midwest Avian Data Center and the Bird Banding Laboratory.

GENERAL CONFIGURATION: A major difference in the Midwest Migration Network and a breeding station is the lack of concern for basing configuration on territories. The Network allows for the shape and size of the Station to be determined by the operator. Positioning of nets should reflect the habitat available and represent bird activity of the station. Bird activity during migration is irregular and inconsistent but highly mobile. Density of nets is at the discretion of the operator, but the station application should indicate the acreage of stopover habitat the station is part of and an estimate of acreage of the station (a100 meter extended polygon surrounding all nets) to provide site information to researchers utilizing network data.

MIST NETS (Single Vs. Multiple Station Sites): The number of nets utilized at a station should be the maximum number that can be operated safely and efficiently in a "**worst case scenario.**" Thus, only the number of nets that can be operated in a standardized manner over the

long term should be established. The number and distribution of nets should be such that all the nets can be checked within 15-20 minutes if there are no birds to extract (i.e., an empty net run). Five nets have been set as a benchmark for the minimum number of nets constituting a station, as it is unlikely that really useful data can be obtained from a station with fewer than five nets. The MMN will consider specific cases of fewer nets if requested.

For the purpose of the Network, the definition of a "worst case scenario" is that one day when everything aligns perfectly for a massive migration movement. This is highly different than breeding study scenarios which are much more predictable. This threshold of bird numbers must be determined by the station operator before field work begins, not when the situation arises. We recognize for a "new" banding station this may need to be determined by experience in the pilot year. In that case, operations must be redesigned for future years. This situation is one of the greatest challenges to developing and running a migration station. In order to follow standardized scientific methodology, bird safety, and data intergradations, this worst case scenario must be considered and addressed before any field work is started. No two net locations are equal for bird captures on any given day, within season, or between seasons, and any consistent variation creates analysis issues that cannot be overcome by statistical analysis. Sample design trumps analysis. Migration, which represents an open population, has already put constraints on analysis; many of which are designed for closed populations.

The capacity of any banding station is a combination of available personnel, abilities of said personnel, weather conditions, and station size. There is not a single recipe for any station to follow beyond protocol, bird, and personnel safety. How many birds a station can process is a function of these parameters. The maximum number of nets that should be operated is that number which on the biggest day of bird movement the operator can expect and handle safely. For example, if a station operates 20 nets, and on the one or two days a season, or on active weather days only 10 nets can be operated safely, then the station should consist of those ten nets, and those same nets run consistently. This would be the primary station. The remaining nets can be operated as a second station on the rest of the field days, separated by different net numbers and station code from the first or "primary" station. Maintain unique net site identification for each station. This separation is not difficult and provides for a constant standardized dataset in station 1 (a Level 1 or 2 station) and additional data from the second station (a Level 2 station). This allows for individual research questions to utilize both "stations" separately or combined depending on qualifications of the question being asked such as comparing capture rates among stations across the region.

MIST NETS (Placement): Nets should be placed at sites where birds can be captured and extracted efficiently, such as the brushy portions of wooded areas, forest breaks or edges, scrub/shrub, and in the vicinity of water. The establishment of net sites at a station should consider the behaviors of various groups of birds such as sparrows and warblers, as their numbers and dominance will change over the season. Also, quick and efficient bird removal should be considered in your net placement.

Habitat use during migration can be very different than that of breeding habitat. It is possible to have "canopy" birds represented consistently throughout migration. Corresponding point counts in the station will help assess station habitat effects. Accounting for habitat may best be achieved

by placing nets in both edge and non-edge portions of the study area. To optimize both the number of birds captured and their capture probabilities, net placement should factor in the available habitat at each station. Because it is not permissible to move nets after the start of the second field season, care must be taken to select optimally-efficient, permanent net sites. Nets stacked two high or placed end-to-end in batteries are acceptable but should be documented. Although artificial food sources are not permissible within stations, they may exist adjacent to stations on property not under the control of the MMN operator (remember that the station boundaries extend outward 100 meters from the net). Net designations may be numeric or alpha but unique within a station and two characters long (e.g. 01, 02, 10). Remember that nets within batteries and stacked nets must be numbered individually. It would be optimal to number each (sub) station differently (e.g. station 1 = 1-10 and station 2 = 11-15 or A-F).

MIST NETS (size, type, and mesh size): We strongly recommend that all nets used in the MMN Program be 12-meter, 30-mm mesh, four-tier, black, tethered, nylon mist nets. Other sizes, types, and meshes may be used if local conditions so warrant, but these variables must remain constant at each net site over all seasons and years that the station is operated. One 12-meter net operated for one hour represents an effort of 1.0 net hour. Thus, if nets of other sizes are used, the effort reported must be adjusted accordingly. For example, a nine-meter net operated for one hour would be counted as 0.75 net hour.

Operating A MMN Station

STATION REGISTRATION: To be part of the MMN, an online station registration form should be submitted for each station. The information on the form provides us with contact information for the station operator or operators. It also provides us with information on the station's geographic setting and information on intended station operations including single vs. multiple station operations. Once a registration form is received for a station, the station operator or operators are added to the mailing list for the anticipated initial banding season.

JOINING THE MMN PROGRAM

If you are interested in establishing one or more MMN stations and feel that you are able to meet our requirements, please contact the MMN Coordinator, Mark Shieldcastle, at mcshieldcastle@gmail.com. You will be sent a registration form on which you will detail the proposed location, habitat, and operation of your station (Appendix 2, Figure 1). You will be added to the roster of active MMN operators and will receive the necessary forms and instructions, as well as annual reports on the results of the program. Please register each MMN station as this helps us plan and budget accordingly and ensures that you receive program and protocol updates.

INSTRUCTIONS FOR THE STATION REGISTRATION FORM

Date: Record the date the form is emailed to MMN.

Station Manager Contact Information:

Name: The name of the station manager, the person in charge of the MMN station and responsible for seeing that changes in forms and protocol are communicated to all personnel at the station. This is MMN's official contact person to whom mailings and

phone calls with data questions will be addressed and who will be acknowledged in publications and reports.

Title: The job title of the station manager within the organization, if any, with which the station is affiliated.

Affiliated Organization: The organization, if any, with which the station is affiliated.

Address and phone numbers: The mailing and e-mail addresses and phone numbers for the station manager.

Federal Banding Permit #: Provide the federal bird banding permit number under which the station will be operated. If you haven't yet received your federal permit, write "in process" in this space and provide the permit number once you have been approved.

Contact Information for an Additional Station Operator: You may provide contact information for another individual with station operation responsibilities on this form. Both operators will be included in our mailing lists and receive mailings concerning station operations. Often, secondary operators are staff biologists, technicians, students, or volunteers who play a critical role in conducting the banding station field work. If more than two individuals should be associated with the station, please provide the additional names and contact information via email at the time the registration form is submitted.

Station Name: Provide a name for your station. If using multiple stations at the same site, indicate as Primary or Secondary (e.g. Creek Bend Primary or Creek Bend Secondary; Pittsfield Banding Station). You will fill out a registration for each station. You may copy and paste information from most categories in the Primary to those of the Secondary. If you have a second station that is in a different location, please name it differently and fill out a separate registration form.

Station Code: Leave Blank - A unique, nine-character numeric code will be assigned to designate your station. This code is to be used as a field in all data sets pertaining to the station such as banding data submitted to the BBL and metadata submitted to the Midwest Avian Data Center. This will allow for merging of the band information and effort and habitat information into a single dataset.

Property Name: The name of the piece of land on which the station is located. May be the same as the Station name or represent a larger landscape designation. Please be precise in listing the property name e.g., Creek Bend County Park; Shaker Lakes Nature Center; or Kalamazoo Valley Bird Observatory. If the property is owned by an individual or family, just write "private property."

Land Owner: The owner of the land on which the station is located. Please be precise in listing the land owner (i.e., for a station in Wayne National Forest, the "United States Forest Service, Wayne National Forest, Athens Ranger District – Marietta Unit"; for Kalamazoo Valley Bird Observatory, "Kalamazoo Nature Center." If the land is owned by an individual or family, just write "private."

Nearest Town: Indicate the nearest community, as the neotropical migrant flies, shown on and listed in the index of a state-level road map, such as the DeLorme Gazetteer.

County: The county the station is located within.

Latitude and Longitude: Please provide the lat/long coordinates in degrees, minutes, and seconds **to the nearest second** for the center of the station; please convert UTM coordinates and lat/longs given in decimals (many GPS units give seconds in decimals). Midwest longitudes are negative.

Source of lat-long coordinates: The information source from which you determined the lat/long coordinates of the center of the station (e.g. hard copy of topographic map, online topographic map, GPS unit, etc.).

Datum: The reference point around which latitude and longitude are structured. If using a topographic map created before 1983 this will be NAD27. If using a topographic map created after 1983, a GPS unit or online mapping information, the datum will be available somewhere on the source. (Google Earth uses NAD83)

First year of operation (expected): Please indicate the year in which you began or plan to begin operating your station. If you wish to include earlier data in the MMN please indicate that on the form. The MMN will contact you to determine what it can accept to incorporate archived data.

General Habitat Description: Use the provided form to complete the HSA. Using key words, provide a brief description of the habitats at the station. Some examples: mixed conifer forest or Cottonwood riparian corridor/dogwood scrub, Great Lake Beach-ridge with buttonbush swamp, etc.

Number of nets: The number of nets comprising the station is recommended to number at least five but should represent the number the station personnel can handle on large bird movement days. In the case of multi-station operations (where there are constant primary nets and additional secondary nets), indicate only the Primary nets for that station and complete a second registration for the secondary station. Note: a six-meter net = 0.5 net. If any nets are stacked, list their net numbers and how stacked: For example, nets 02 and 03 stacked: 02-low and 03-high.

If any changes are made in a given year or season, this registration form should be re-submitted indicating changes were made and an explanation as to why. This allows for a detailed history of the station to be incorporated into the metadata that will be of value to long-term dataset use. Describe net changes from last year. Indicate any previously operated nets that were not operated in the current year and any new nets added. Please note that any moved nets will require new net numbers.

The LEVEL you wish to enter the Network at: From the descriptions explained earlier in this manual, indicate the Level (1, 2, or 3) this station fits.

Periods of operation: The MMN can accommodate stations that operate during spring or fall, or both. It is preferred that the station cover at least 75% of the migration period,

whether daily or intermittent. However, short bursts of field activity can assist in many questions the MMN is being formed for. Please indicate dates for the planned field operations of the station.

DATES OF OPERATION:

Timing

Temporal measures are of major importance to any migrational monitoring program. Each species has an annual migrational timing which may vary by sex and age cohorts. Time of day also seems to correlate with specific activity periods. These are associated with sunrise and sunset and can be affected on a daily basis by environmental conditions. Generally, daily weather effects cannot be controlled and will remain a variable in any data set. However, standardization of banding and counting activities to time of day can reduce the number of variables affecting data collection. The MMN will create a set of preferred requirements and the variation of each that will be tolerated and still be utilized for analysis.

Seasonal Time Period

Banding and point count efforts should cover a minimum of 75% of the migration period for the study site. Every attempt should be made to equalize any unsampled parts at the beginning and end of the migration period. The migration period should be considered for short distance migrants as well as Neotropical migrants. It is recommended that field surveys be conducted during both spring and fall migration. Considerable variation can be seen between seasons on some sites and is invaluable in assessing stopover habitat criteria. Differential migrational paths and landscape effects can be accessed if both spring and fall migration periods are sampled. This does not preclude stations that are presently or projected to open for an intense but short period (2 weeks). These stations can still be used to answer some questions.

While of less concern with spring migration, fall migration timing for a given site is affected by latitude, longitude, and altitude. Bird activity can also be affected by staging and dispersal migrations that precede true north-south migration. Identification of important staging areas will be an important objective of the MMN.

Day Time Period

Bird activity is greatest in the early morning hours during migration. Birds arriving during nocturnal migration tend to reduce activity and disperse as the day progresses. Activity is lowest midday and may increase again towards sunset. There appears to be differences between spring and fall migrations at some locations. The recommended operation time for this study is one-half hour before sunrise to at least 1100 hours for netting, and point counts to be initiated within one hour of sunrise. This is a general guideline and is not implied as required for participation. Capture rates can be misleading for stations that only operate during the first couple of hours when activity is greatest. While this does not affect all question analyses, it needs to be considered and is why the minimum field hours is recommended. Banding should not be based on volume of capture without considering how your operations could affect bigger question

needs. Documentation of net erection, and shut down, and time of bird banding can allow for comparison in slight variation in stations but documentation will allow the individual researcher to determine inclusion or exclusion of data sets.

Standardized point counts and daily lists should be limited to netting and shut down time. This will allow for comparable data between methods. Each station will need to provide definition for their standard operational procedure and particular data for each day of operation. All daylight hours are potentially available for this study.

BANDING

The central focus of this project is intensive monitoring of avian migration through capture/recapture. Capture and handling of birds provide analysis opportunities not available with other monitoring methods. It produces a random sample of each species and can be relatively selective. It can be useful for calculating population size, health, habitat use, connectivity, and composition. Detailed demographic information on age and sex classes can provide comparisons annually, seasonally, spatially, and between species. It provides a means to identify, quantify, and analyze stopover birds and residents. While the primary source of data for this project will be attained through mist netting, the project will accommodate other types of random capture such as non-baited traps. However, birds captured by alternate means will need to be identified in station records as capture probabilities differ. Capture methods can not include any form of baiting or attractants as this affects behavior and cannot be standardized over time. Standardization of effort is extremely important in the success of any monitoring project. Weather, population fluctuation, operation variation, and habitat changes can all affect valid data. While standardization across stations would be ideal, standardization at each station is a necessity, and any variance in activity needs to be well documented to assist in analysis of data. To provide the best data set possible, several recommendations on banding activity will be included here. While strict adherence is not required for participation, in-depth quality documentation of methodology and any variance from the norm needs to be supplied with any data submitted. Recommendations for operations include:

- Establishing nets in the same location year to year and efforts to maintain the same number and type of nets hour to hour, day to day, and year to year.
- Documenting any change in net location or major deviation from the normal net operation.
- Standardizing net operation should be standardized to time of day. The preferred operation time is a constant start up time in relation to sunrise, which is recommended as one half hour before sunrise. Morning is preferred but other times are acceptable. Similarly, nets should be closed daily at a similar time when possible. This would standardize time of day and number of hours. Bird activity is greatest early morning and can show difference in capture rates between stations with variation in shut down time. This problem can be reduced by recording the capture time of each bird encountered as <u>end</u> of net run (time last net is checked). This would permit sub-setting stations with longer netting periods for comparison purpose to other shorter time frame stations.
- Recording non-standard opening and closure recorded of nets along with their causes. Partial closure or opening should be avoided whenever possible but recorded when necessary.

- Developing a systematic shutdown should be developed for any special circumstance to reduce data variability.
- Closing nets as quickly as possible if conditions endanger safety of the birds.
- Maintaining habitat conditions at sites may be required because of canopy effect on capture.

OPERATION OF NETS

The importance of standardizing effort between seasons and between years cannot be overemphasized. The accuracy and precision of MMN indices and estimates depends on effort being equal, both in quantity and in timing, at all stations and all years. Thus, the number of nets operated and the timing of their operation should be standardized to a minimum requirement (1/2 hour before sunrise to 1100 hours) for all days of operation and kept constant from year to year at each station. It should be the goal that the first net be opened at approximately one half hour before sunrise. Thus, starting time will change during the course of the season. The nets should be opened in the same sequence on each day of operation. If possible, they also should be checked in this same sequence on every net run. They should remain open, if possible, to at least 1100 hours and should be closed in the sequence in which they were opened. Nets should not be operated if weather variables are likely to endanger the lives of captured birds. Efforts to lure or drive birds into nets are not permitted.

It is highly desirable for standardization of data collected on individual birds. While age and sex requirements are universally accepted with specific guidelines, many other parameters such as lipid deposits have several accepted methods. The following will be the set guidelines for the MMN project. Deviation from these must be completely documented for repeatability and compatibility purposes.

Age and sex criteria will be that as accepted by the BBL. It is imperative to age and sex birds to the fullest extent possible to efficiently look at age and sex effects on migration and develop useful age ratios for life cycle models. Two additional measurements are highly desirable and will be necessary for some analysis operations.

1- One of these will be wing chord measurement. This is to be unflattened wing as recommended in North American techniques. Measurements are to be taken to the closest millimeter.

2- The preferred method of lipid condition determination is that of Helms & Drury (1960). This seven point scale is easily and quickly measured and can be subjectively sub-divided to half points in the field. See Figure 1 for graphic illustration of this scale. This method provides for a more continuous scale and allows for more efficient statistical analysis. If participants have long term datasets utilizing different scaling techniques, it is recommended that one to several species are used to develop comparisons to Helms & Drury for data continuity. The present MAPS lipid classing is very similar to Helms & Drury and can be used if documented by station registration. Any other method needs to be well documented for project purposes and repeatability. However, it is recommended that new stations adopt the Helms & Drury method.

Additional measurements may be taken similar to those of MAPS programs if time and bird

safety permits.

Time of banding is an important data point in standardizing sites across the region. This will allow sub-sets of stations that band for longer time frames to be compared to other stations depending on the question being addressed. It is recommended that the time of banding be **standardized to the time of the end of the net run (when last net is checked for that round)**. Since most, if not all, activity will be in relationship to sunrise, this will facilitate putting capture in context to this important parameter of bird activity, and it ensures the individual bird was captured by a certain time. It is not possible to identify most birds to actual capture time as the real parameter is somewhere between net runs. To utilize the beginning of the net run results in miss-assignment of individual birds, as many are actually captured after the time recorded, which is a more crucial error in relationship to sunrise. It will also assist in sub-setting birds captured in similar time frames depending on the research question. Again, variation from this protocol needs to be documented to allow for accountability in any analysis.

An important component of any capture/recapture method is accurate records of subsequent encounters of banded birds. This project will recognize four categories of birds: new banded, returns, foreign recapture, and recapture. New banded birds are those encountered for the first time and indicates the original banding of the bird. Any subsequent encounters of that bird during the calendar year would be classified as a recapture. These recaptures may constitute a stopover of a migrant at the station or a resident or breeder of the banding site. A return is an encounter of a bird originally banded in a prior year within the same ten minute block. For some analyses, this encounter will be treated similar to a newly banded bird. Subsequent encounters of a return bird in the same year will be treated as a recapture. A foreign recapture represents any banded bird that was banded by a different permit. Data collected should be the same as that collected on a new bird. All recaptures and returns should be reported to the BBL using the proper module in Bandit or its replacement. It is recommended, when possible to record the net of capture of all previously banded birds. This may serve as valuable information in establishing individual breeding birds of species that may be predominantly a migrant species for the station. Data to be collected on all returns and recaptures should also include band number, wing chord (return only), mass, capture time, and lipid condition. All banding data will be entered through the BBL process and can be integrated into the MMN through coding included in the individual records.

EFFORT DATA: Effort data is defined as the effort made to capture the birds in the data set and is critical for comparing capture rates within a station, between stations, and among years and seasons. Because daily activity patterns differ both by age class and species, time of season, net-by-net, and hour-by-hour, effort data is necessary for assessing production, survival, and for estimating bird numbers. The importance of net standardization cannot be under estimated for its role in any future analysis.

HABITAT STRUCTURE ASSESSMENT (HSA) data: Habitat use by migrant birds can be very different from resident or breeding birds. Habitat patches that would not represent suitable conditions for a breeding individual may meet all the needs of that same individual in migration. Recognizing these differences influences the routine information that needs to be collected to inform researchers interested in utilizing Network data. The primary function of the habitat

structure assessment metadata for the MMN is to provide a classification for each station and permit detection of gross changes in habitat structure at the station. HSA's should be conducted every five years, unless the habitat at your station has undergone a major change (e.g., fire, hurricane, logging, construction, brush-clearing, etc.). The form is in Appendix 2, Figure 2.

The primary parameters the MMN will collect in the HSA form includes:
- Distance from the Great Lakes, other large lakes or rivers, and Mississippi River
- Dominant canopy and height; % conifer, deciduous
-dominant understory and height
-dominant herbaceous and height
-water resources in the vicinity of the station
-relief/topography of the station
-is the station a natural travel corridor or not
-anthropogenic influences in the area of the station
-threats to the habitat and future continuation of the habitat type
-landscape map indicating nets

POINT COUNTS

A banding station that includes point count methodology increases the quality of data collected. Not all species are equally susceptible to capture in mist nets or other capture techniques. Larger passerines and those with long tails do not "hold" at the same frequency as smaller passerines. Many species are canopy dwellers and may be encountered at the level of nets in different frequencies due to canopy height, atmospheric condition, precipitation, or wind, which may have no connection to bird abundance. Additional species are diurnal migrants and are not likely to be captured, including: Blue Jays, blackbirds, and the swallow family. A structured systematic point count will provide a check to the highly qualitative banding data. Data on species not targeted by the banding operation such as waterfowl, waders, and shorebirds may also be collected and compiled with this method, and provide a data source for researchers utilizing the MMN. The point count route needs to be developed in relation to net placement for comparison analysis and standardization at each site cannot be over emphasized.

Advantages with this method include the involvement of routes around banding stations to develop a wider network. This would permit partnerships with Audubon or bird clubs in additional locations around a banding station where banding is not possible or sufficient trained personnel are not available. It can be completed in a short time by one person and does not require special skills in handling birds. The method is unselective to species, but secretive species may be missed. It is important to recognize that migration point counts are often more complex than breeding counts due to greater bird density and bird mobility while at the site.

There are considerable problems with Point Count methods, and any sample design utilizing them is affected by its potential as a stand-alone program. Observer abilities will vary greatly in detectability and accuracy, and training in ID may be time consuming. Males and females migrate at differing times in most species and can skew species timing as males are more colorful and vocalize differently than females. Resident and migrant birds are extremely difficult to separate, and turnover rates will be hard to assess. Variance in vegetation can cause systematic

problems between sites and seasonal timing within sites for analysis. While accuracy may be influenced by weather, counts can be conducted when netting cannot, providing some continuity to data collection.

Guidelines for this project are to include point counts for all three levels of participation. Points along a transect are recommended over a transect method. A point count is easier at a landscape scale to quantify and, with the exception of grassland habitat, superior in bird counting. A route should be developed within the bounds of the area covered by nets and points established with a minimum of 120 meters apart. A map (and GPS coordinates) demonstrating both points and nets on the habitat background will be required. The route should be run once all nets are opened and attempts to standardize near sunrise are to be made. Each point is to be surveyed for 5 minutes and all birds seen or heard recorded. Stations should have a minimum of three points and at least two in each sampled habitat. At this time it will not be necessary to record distance or develop known distance bands for each point and to indicate if the bird is perched or a flyover. However, this is being discussed for future use. This may change as the MMN analyses become more refined. Analysis will center on daily comparisons in concert with banding, if banding is conducted. Comments on weather conditions, primarily precipitation and wind speed, are to be collected to permit data exclusion if analysis shows conditions that create outliers. Conditions permitting, on days that banding can't be conducted at Level 1 and 2 stations, the point counts can be completed to gather some information of bird activity that day. A recommended form is displayed in Appendix 2, Figure 3.

Point counts conducted during migration have a major confounding factor not encountered in breeding point counts. This concerns a changing visibility throughout the spring and fall seasons. It is assumed in breeding point count programs that the observer's ability to see birds does not change during the sample period, whether the study design utilizes one count or several during the breeding season. This is not the case during spring and fall. The ability to see through vegetation is very different if the count is in early April or late May, the same holding true if late August and late October. This is a result of leaf out or leaf fall. To assess this and its affects, there is ongoing research to incorporate a visibility index to the point counts. The functionality and feasibility of creating this model is ongoing and if promising may be incorporated into the MMN protocols down the road. Any station manager that would be interested in this work is encouraged to contact the MMN, and guidance will be provided.

DAILY LIST

A final layer of data will be a daily list. This is strictly a quantitative data set and will report presence/absence. It will assist in quantifying movement timing of rare and unusual species. This method can be done in any weather but requires the more qualitative methods to have any degree of scientific merit and should be considered solely supplementary information. It requires little additional effort from field teams as it can be done during other operations and may heighten interest and focus of volunteers throughout the day and season. No special skills in handling of birds are needed, but skills in observers and number of observers may add variability to site and regional analysis. Improved standardization in this method can improve data value with consistent procedures or rules resulting in similar effort daily. A List should be kept for the time period that nets are available to capture birds plus one hour before and after. The list should

contain the area of netting as its location base. For third level sites that only conduct point counts, list may include the time period of the count or be conducted during a standardized time such as sunrise to 1100 hours and will include those areas between points. Whatever choice a station utilizes it must be kept standard day to day and year to year. Any bird list phamplet can be used in the field for data collection. A recommended computer entry form is included in Appendix 2, Figure 4.

TRAINING PROGRAMS

The MMN will provide training for all aspects of the program. Modules of the training program will include but not be limited to Network Participation, Bird Banding Permit Regulations, Sample Design, Mist Net Operation, Bird Safety, Aging Techniques, Fat Classing, Fieldwork Efficiency, Auxiliary Data Collection (ex. Feathers), Habitat Data, Point Counts, and Daily List completion.

It is the objective of the Network to complete a series of training sessions across the region and to accommodate requests for tailored sessions. North American Banding Council materials will be incorporated into every training session.

STATION OPERATION

COLLECTION AND RECORDING OF EFFORT DATA

The summary of field effort collected by stations provides the framework to interpret bird data, whether it consists of banding, counts, or lists. Effort data standardizes other collected data for comparisons at all levels of analysis within or between stations, seasons, and years. It is critical that this be completed exactly as indicated and submitted through the Midwest Avian Data Center (MWADC) portal. Please review this section of the manual carefully before completing the Mist-Netting Effort forms. This highlights the importance of standardization in mist net use, opening, and closing times. Remember, the opening and closing times you should record are those for when the middle net is opened or closed. This allows for accounting of various bird activities at your station that can affect both opening and closing efficiency. These data can be entered directly into the MWADC portal or downloaded from the provided external file at the end of each season. Each day of operation will require at least one record. For Level 1 stations, enter closed days with an explanation for the reason of no activity. A recommended form is in Appendix 2, Figure 5.

GENERAL PROCEDURES FOR RECORDING EFFORT DATA

Location: Station name.

Station: Record your nine-character station code.

Date: Record the month, day, and year of the date of operation.

Number of Nets: The number of nets should equal the number registered for the station. If different sizes are used at your station other than the recommended 12 m, then use 0.5 for a six meter net and 0.75 for a nine meter net in the net calculations. If circumstances arise that the protocol can't be followed and not all nets are opened on a given day or some nets opened for only a portion of that day, effort should be recorded on multiple lines. For example, if your station utilizes 25 nets and all were opened at 0600 and nets 12 and 15 were closed at 1000 due to sun or wind while the remaining 23 were closed at 1130, then the effort should be recorded on two lines. If there are multiple closing episodes, then each will utilize another line. The deviation in net protocol should be recorded in the comments field. This will allow any researcher utilizing the Network to judge if the deviation affects their analysis for their question. NOTE: Nets that are run (when conditions or personnel allow), above and beyond the standardized nets listed on the registration form, should be entered as a separate station and have a second registration form.

Open Time: This time should be recorded in the same format as capture and closing times. That is, using the 24-hour clock, record, to the nearest 10 minutes, the opening time of the middle net opened. Example: if you use 20 nets, the time after net 10 is opened represents the opening time (25 nets then the 13th net to be opened is the open time).

Close Time: This time should be recorded in the same format as capture and opening times. That is, using the 24-hour clock, record, to the nearest 10 minutes, the closing time of the middle net closed. Example: if you use 20 nets, the time after net 10 is closed represents the closing time (or, for 25 nets closure of the 13th net is considered the close time).

Net Hours: If you are using the electronic form, Net Hours will be calculated by the form and filled in. If you are using a hard copy and submitting to the MWADC please calculate the net hours accumulated (to the nearest 0.01 net hour) for the nets recorded on each line.

Comment: Record a comment indicating why nets were opened or closed at times that deviate from the standard protocol. The comment must not exceed 40 characters in length.

COLLECTION AND RECORDING OF BANDING DATA

All birds captured throughout the season, including recaptures and returns, must be identified at least the sub-species level and must be aged and sexed to the most precise level possible (use "unknown" if necessary). Age and sex birds by the appropriate plumage and molt characters or, if applicable, by extent of skull pneumatization and/or breeding characters (Bird Banding Offices 1991, Pyle 1997). Incorrectly identified, aged, and/or sexed birds are detrimental to analyses. All birds not already banded and not excluded from the operators banding permit must be banded with a numbered aluminum band issued by your country's banding office.

Pyle (1997) is considered the authority for in-hand age, sex, and difficult species determinations of North American passerines and near-passerines. The information in this book is accepted by the banding offices, and MMN banders are expected to use this book in the field. Please ensure that you understand the concepts presented in Pyle (1997) and in Pyle

Volume 2 and apply them appropriately. Please also ensure to correct your copy of Pyle (1997) with the latest version of the errata (http://www.slatecreekpress.com/errata.htm).

All banding and recapture data are to be submitted to the Bird Banding Laboratory through Bandit4 or its successor. All BBL fields are considered Primary MMN data along with station code, capture time, wing chord, body mass, and fat class. Additional data may be included at the discretion of individual cooperators or specific projects the cooperator is assisting in. Cooperators have the choice of utilizing their own data entry field forms or to adopt the template included in these instructions. All that is required is the inclusion of all primary MMN data fields. The Bird Banding Laboratory will be revising Bandit4 in the near future to accommodate additional fields for both MAPS and the MMN. The intention is to reduce double reporting as both MAPS and MMN will acquire the banding and recapture data from the BBL and not require cooperators to report bird data directly to the programs.

GENERAL PROCEDURES FOR RECORDING BANDING DATA

Primary MMN data: Primary MMN data are the data upon which all analyses of age ratios, energetic condition, productivity indices, survival-rate estimates, and population trends for the Network will be based. Thus, it is crucial that complete primary MMN data be taken on all birds captured, including recaptures. Primary MMN data includes all the required data fields of the BBL such as band number, species, age, how aged, sex, how sexed, status, date, and the additional critical fields of capture time, station code, disposition, wing chord, body mass, and fat class.

Supplemental data: MMN operators are also asked to collect supplemental data on all birds captured, and recaptured: net number, and feather pull if collected. These data may be used in verification programs to assure the accuracy of the species, age, and sex determinations.

Optional data: Additional data, including many of the MAPS fields such as exposed culmen, tarsus, tail length, extent of skull pneumatization, breeding condition (presence or absence of a cloacal protuberance or brood patch), extent of body and flight-feather molt, extent of primary-feather wear, extent of juvenile plumage, existence of molt limits and information on feather generation for selected feather tracts or groups of feather tracts may also be taken, if appropriate, but are not required.

Codes, scales, and forms: All data should be taken according to the guidelines of the BBL in addition to utilizing the standardized codes described in these instructions. We realize that some cooperators to the MMN Program have long been recording many of these data according to slightly different codes and scales. If you find it impossible to adopt these scales and codes, you must provide us with an explanation of how your codes correspond to MMN codes so that they can be converted. Since many cooperators are familiar with the MAPS program and its coding, the MMN will accept those codes in all data fields. The only major deviance is in the recording of fat class. It is recommended that MMN cooperators use the graphic depiction of Helms & Drury (1960) provided here as the primary choice, but will accept the MAPS fat class codes as well. There are advantages to

the preferred classing covered here, but as long as it is indicated in the metadata submissions (preferred or MAPS class), the method correction calibration can be completed.

It is the intention of the MMN that all data will be reported electronically. With that in mind, the MMN is not requiring cooperators to utilize a specific field data sheet. That is at the discretion of the bander. This can include a user developed form, the MAPS form, or the template included in these instructions. Not all fields requested by MAPS are required for the MMN as this is not a breeding time frame and is a different part of the life cycle. The template will include two different field collection sheets for bird data: the **MMN Banding Sheet** for recording the use of new bands and the **MMN Recaptures Sheet** for recording recaptures (appendix 2, Figures 6 and 7).

Multiple-station locations: If the station protocol requires that more than one station be operated at a given location as described above, either assign band strings to each station or ensure birds captured in each station have the proper station code entered in each banding record, recapture record, and effort record.

Non-MMN data: Banding data from non-MMN sites (e.g. breeding, traps, feeding stations) or collected outside of the migration season should not be included in MMN data. Banding and recapture data will be flagged in the station code field of the BBL files. Effort and station metadata submitted to the MWADC will only include records associated with the banding and recapture data submitted to the BBL.

Recaptures: Every capture of a banded bird is a "recapture." Recaptures thus include returns (first captures in the current year of birds banded previously in the same place on the same permit), repeats (subsequent captures, even on the same day, of birds banded or recaptured in the same place earlier in the current year), and recoveries (first captures of birds banded in a different place or on a different permit). Birds banded outside of MMN operation and recaptured during MMN operation are considered recaptures. Complete data should be taken for all recaptures and should be recorded only on MMN Recaptures Sheets or cooperator created forms and submitted to the BBL.

Added bands and Mortalities: Any circumstance that results in the need a band replacement or the death of a bird should be reported through the guidelines of the Bird Banding Laboratory. Mortalities should be placed in a sanctioned repository such as a museum or education center. Destroy the band unless it is a recovery, in which case, report the band through Bandit or submit the information electronically at http://www.reportband.gov.

Banding-data fields

The following section covers the instructions for all banding and recapture data fields in the banding record. Instructions for required data fields will be explained in detail in order of their importance. Primary data fields will be covered first, then supplemental data, and lastly optional data. In all cases, the optional data represents data collected by MAPS during the breeding season and the instructions included here reflect those given in the MAPS manual. While most

cooperators have been collecting data for a period of time, a template form is included for new cooperators of migration studies for their convenience in setting up their study. All primary data fields must be part of the band and recapture data fields must be reported to the BBL, if at all possible.

If using the MMN template provided in these instructions for Bandit or other data entry for BBL submission, please consider these tips below. Write out completely the first record on each sheet each day. After that, use a "greater than" (>) or "less than" (<) symbol in the BAND NUMBER, SPECIES NAME, STATUS, DATE, CAPTURE TIME, and STATION fields if the entry is repeated on the next line; do not use ditto marks or vertical lines as they can be mistaken for '1s and do not use these symbols in any other fields. If data for a given field is not collected, leave the field blank; do not use zeroes, nines, hyphens, slashes, or any other symbols to designate data not taken. Please record all data taken, even if the values are "0" and do not make assumptions.

PRIMARY DATA FIELDS

Band Number - For new, lost, and destroyed bands, enter the complete band number for the first band on the first line of each page. Enter these exactly the way you want them to appear in Bandit. Please double-check to be sure that this first band number is completely correct. Thereafter, for all other band numbers on the page, enter only the last three digits right-justified.

For all recaptures, however, be sure to enter the full band number each time. Furthermore, please double-check the band numbers on all recaptured birds before releasing them. A good technique to use for insurance is having the band number read backwards. Incorrect band numbers on recaptures are the most serious errors of all because correct band numbers on recaptured birds are the basis for all mark-recapture analyses. We strongly recommend the use of some form of optical magnification to read the band numbers.

Species – We strongly recommend the use of either, or both, the alpha and numeric four digit codes recognized by the BBL. The template includes both, but it is the discretion of the bander and how data will be entered into Bandit as to which field will be used. There is an advantage of using both to act as a check for each as for example the hand written M and N can be very similar. The same can be noted for 1 and 7.

Status - Record status as a single, three-digit code as shown in Bird Banding Offices 1991 (revised 1992); http://www.pwrc.usgs.gov/bbl/manual/status.cfm. The most-frequent Code is "300" - normal wild bird captured, banded, and released; additional codes should follow BBL codes and the authorizations of the cooperators banding permit. Please note that status "000" birds are now requested to be included in schedules submitted to the banding offices if they are mortalities.

Age - Enter a single-digit numeric code for the age class of the bird that is deemed appropriate for the time of year, species, and sex, as described in Pyle (1997). We strongly

recommend the numeric code as it requires a single digit field instead of up to three digits for the alpha code. Enter into Bandit the choice you have created in your settings.

1 - After Hatching Year (AHY): A bird known to have hatched before the calendar year in which it is captured; year of hatching otherwise unknown. Can be used for all species (not always the preferred choice) in spring migration and in most cases in the fall (there are exceptions depending on capture date – Confirm through Pyle (1997).

2 - Hatching Year (HY): A bird capable of sustained flight and known to have hatched during the calendar year in which it is captured. This will only be used during fall migration.

4 – Local (L): A bird incapable of sustained flight, recently exiting its nest. This is not an age of a migrant bird. It can be included or excluded from MMN data. Most analysis will exclude this age class.

5 - Second Year (SY): A bird known to have hatched in the calendar year preceding the year in which it is captured (known to be in its second calendar year of life). This class will be most often used in spring migration but for certain species will be used in fall migration. Confirm through Pyle (1997). It is very important to become familiar with molt and wear patterns as the more birds that can be precisely aged in spring migration the more informative age ratios can be. Improved ageing techniques in the spring can inform winter survival and be compared to fall age ratios for model informing.

6 - After Second Year (ASY): A bird known to have hatched earlier than the calendar year preceding the year in which it is captured (known to be at least in its third calendar year. Most often used in spring migration but for some bird groups (woodpeckers can be used in fall) follow instructions in Pyle (1997). It is very important to become familiar with molt and wear patterns as the more birds that can be precisely aged in spring migration the more informative age ratios can be. These more definitive age ratios can inform winter survival and be compared to fall age ratios in model development and operation.

7 - Third Year (TY): A bird known to have hatched two calendar years prior to the year in which it is captured (known to be in its third calendar year). Seldom used except in certain bird groups, follow Pyle manual.

8 - After Third Year (ATY): A bird known to have hatched more than two calendar years prior to the year in which it is captured (known to be at least in its fourth calendar year); year of hatching otherwise unknown. Seldom used except in certain bird groups, follow Pyle.

0 - Indeterminable (U): Age unknown because age is indeterminable; i.e., age determination attempted but not possible with confidence. Never to be used in spring migration as all birds are at least AHY.

In spring, please attempt to age adult birds as second year (SY) or after second year (ASY). It should be possible to reach this level of precision with at least most individuals of roughly 95% of North American passerine and near-passerine species and most or all individuals of some species, especially many warblers. In addition, many near-passerines (including woodpeckers) and a few passerines may be aged to third year (TY) and after third year (ATY). Our ability to index juvenile survival rates and estimate recruitment rates of young and immigration rates of adults hinges on your ability to discriminate between SY and ASY age classes. Since the

presence of juvenile or first-alternate feathers indicates SY, whereas the lack of such feathers often is not definitive, it is likely that more SYs than ASYs will be identified. The proportion of birds assigned to each age class generally should reflect the proportion suggested in the species bar graph in Pyle (1997).

How Aged – (From Bird Banding Lab) How-aged codes indicate how you determined the age of the bird. Use only the appropriate code(s) for the banding time of year:

AM –Auxiliary Marker on bird at capture (used with any age): Birds with auxiliary markers (like web tags) and no federal band or with foreign bands may be micro-aged. Can be used with recaptures for ages beyond SY, TY.
BO – Behavioral Observation (used with HY, AHY): Includes singing, incubation, mating/copulation, etc.
BP – Brood Patch (used with AHY): Generally used for How Sexed, but can be used to age AHY only.
BU – Bursa of Fabricius (used with any age): Most useful in waterfowl.
CA – Calendar (used with AHY): For AHY (instead of Unknown) between 1 January and beginning of normal fledge time, depending on species, latitude. For birds that can't safely be called SY.
CC – Combination of Characteristics/measurements (used any age): Characteristics or measurements that, alone, would not be usable. Describe in remarks.
CL – Cloaca (used any age): Waterfowl cloacal exam, male cloacal protuberance, distended cloaca of female shorebirds.
EG – Egg in oviduct (used with AHY): Generally used for How Sexed, but can be used for AHY.
EY - Eye color (mostly used with HY, SY, AHY, ASY):
FB – Fault Bar (used with HY, SY): Uniform fault bar on juvenile tail feathers (Fig. 19 in Pyle vol. 1, Fig. 18 in vol. 2), sometimes in juvenile remiges.
FF – Flight Feathers (remiges), condition and color (used with HY, SY, AHY, ASY): Wear, freshness or color of primaries, secondaries or tertials.
IC – Inconclusive, Conflicting (used with U, AHY, ASY): Generally used with age U, but can be with AHY or ASY if micro-ageing characteristics are conflicting or inconclusive.
LP – Molt Limit Present (HY, SY – passerines; greater than HY – raptors): In passerines can distinguish HY from AHY (Fall) or SY from ASY (Spring) in secondary coverts or alula. Or in raptors, among secondaries and primaries (AHY, SY, ASY, TY, ATY).
MB – Mouth/bill (mostly used with HY, SY, AHY): Refers to mouth/bill color, or bill shape, culmen length, striations (hummingbirds), depending on species.
MR – Actively molting remiges (used with AHY): Useful in late Summer/ early fall for AHY in species with partial preformative molt. Not to be used with species that has a complete pre-formative molt.
NA – Not Attempted (used with U): Age U only.
NF – Nestling recently Fledged, incapable of powered flight (used with L): Usually ages L, but HY under certain circumstances.
NL – No molt Limit (mostly used with AHY, ASY): In passerines, can distinguish AHY from HY (fall) or ASY from SY (spring) in secondary coverts or alula. Or in raptors, among secondaries and primaries (HY, SY).

NN – Nestling in Nest (altricials), downy young (precocials) (used with L): Use for age L only. This does NOT mean an adult who has young in nest.
OT - Other (used with any age): Explain how aged in remarks.
PC – Primary covert wear and/or shape (used with any age): Primary Covert shape can be used (with experience) for ageing many species. Primary covert wear is especially useful for ageing woodpeckers (Pyle Fig. 122).
PL – Body Plumage (mostly used with HY, SY, AHY, ASY): Color of or patterns in body feathers, including head, breast, back, coverts.
RC – Recaptured bird with USGS band (used with any age): Can be used with recaptures (including replaced bands) for ages beyond SY, TY.
SK - Skull (mostly used with HY, (SY), AHY): Most useful for HY vs. AHY. Some individuals are slow to pneumaticize and can be called SY after 31 December.
TL – Tail Length (used with any age): Only useful for ageing in a few species.
TS – Tail Shape or Wear (mostly used with HY, SY, AHY, ASY): Generally, badly worn and /or pointed in HY, SY and less worn or rounded in AHY, ASY.

Sex – Either alpha or numeric codes may be used in this field. Utilize what you are most comfortable with. Males are 4/M. female are 5/F. Unknown sex is 0/U. Utilize Pyle manual to attain as accurate of a determination as possible.

How Sexed – (From Bird Banding Lab) Use the codes below as in HOW AGED above.

BO – Behavioral Observation: Includes singing, incubation, mating/copulation, etc.
BP – Brood Patch: Use only with females.
CC – Combination of Characteristics/measurements: Characteristics or measurements that, alone, would not be usable. Describe in remarks.
CL – Cloaca: Waterfowl cloacal exam, male cloacal protuberance, distended cloaca of female shorebirds.
DN – DNA/chromosome analysis
EG – Egg in oviduct: Sex F only.
EY - Eye color: Iris color, also presence/absence of flecks in Black Oystercatchers.
FS – Feather Shape (Primaries or tail): Useful with hummingbirds, woodcock, snipe.
IC – Inconclusive, Conflicting: To be used with sex U only.
LL – Laparotomy/laparoscopy: Requires specific authorization from BBL/BBO.
MB – Mouth/bill: Refers to mouth/bill color, shape, or culmen length, depending on species.
NA – Not Attempted: To be used with sex U only.
OT - Other: Explain how sexed in remarks.
PL – Body Plumage: Color of or patterns in body feathers, including head, breast, back, coverts.
RC – Sexed upon recapture: Used for birds banded at a time of year when they can't be reliably sexed, but are recaptured later when they can be.
TL – Tail Length: Used with caution for sexing; HY birds average shorter than AHY. For some species length of certain individual tail feathers can indicate sex.
WL – Wing Length: Use with caution for sexing, HY birds average shorter than AHY.

Date (MO/DAY/YR) - Month/day/year. Record the date of capture as month, day, and year, all in numbers. Record all months, days, and years as two-digit numbers (051017). This should be completed as entered into Bandit.

Body Mass - Record the mass of the bird to at least the nearest tenth of a gram. If the options available are not that accurate go to the nearest 0.5 gram with a Pesola scale.

Wing - Wing Chord. Record wing chord (the length of the unflattened wing) to the nearest mm. See Pyle (1997) or Ralph *et al*. (1993) for an explanation of the technique. Unless there is little or no overlap in wing lengths between sexes (e.g., icterids), DO NOT sex birds by wing length alone in the absence of population-specific wing chord data.

Capture Time - Using the 24-hour clock, record, to the nearest 10 minutes, the ending time of the net run on which the bird was extracted. Thus, all birds extracted on a given net run will have the same capture time. This may be different then other programs you may participate in but many years of experience has proven this to be the best record time for migration banding where most if not all is morning centric with the changing of natural bird activity during the migration season. This is necessary for standardizing effort between years. Since morning is when most banding will be done, this will indicate a last possible time of capture. This is important for standardization between stations, years, and seasons. It is not possible to conduct all rounds with same length. Do not enter the time at which the bird was extracted, processed, or released. Always enter four digits.

Station - Record the nine-character code for the MMN station as determined during station registration.

Fat - The identification of the amount of subcutaneous fat is extremely useful in determining energetic condition and standardization of mass. Unlike breeding season, fat content and use is extremely variable during migration. It is likely influenced by weather, suitability of habitat stopover sites, species, and individual behaviors. The MMN will accept two methods of fat classing as they are both very straight forward and utilize a many point scale that provides more opportunity for analysis. The preferred method is Helms & Drury (1960) and illustrated here from a figure created by Dr. Frank Moore of University of Southern Mississippi (Figure 1). It is a seven point scale that, with the illustration easily allows for utilizing half points between each primary classification (ex. 3.5). This provides for a nearly continuous variable that has analytical advantages. The biggest difference is that it is based first off of the fat buildup in the abdomen region of the bird while the other method accepted here (MAPS) is based upon the furculum fat first. From the monitoring of 100,000s of birds during migration, the abdomen fat appears to be more consistent in classification. MMN has included the write-up from the MAPS manual for fat classing explanation for that method. The only difference for the Helms & Drury method is to first check the abdomen.

The stored fat can be seen clearly through the nearly transparent skin and contrasts with the dull, dark-reddish breast muscles color. It is seen most easily by holding the bird on its back while placing the index and middle fingers on the front and back of the bird

neck, stretching the head slightly forward along a line parallel to the body, and gently blowing the feathers away from the upper breast to expose the furculum (MAPS); abdomen (Helms & Drury). Then check the abdomen, under on the wing, again by blowing the feathers gently out of the way (Helms & Drury does not require a check of the wingpits). For the Helms & Drury method the visual observation can quickly be placed into a class and if it does not fit either class precisely the half point (does not fit class 2 or 3, therefore record 2.5).

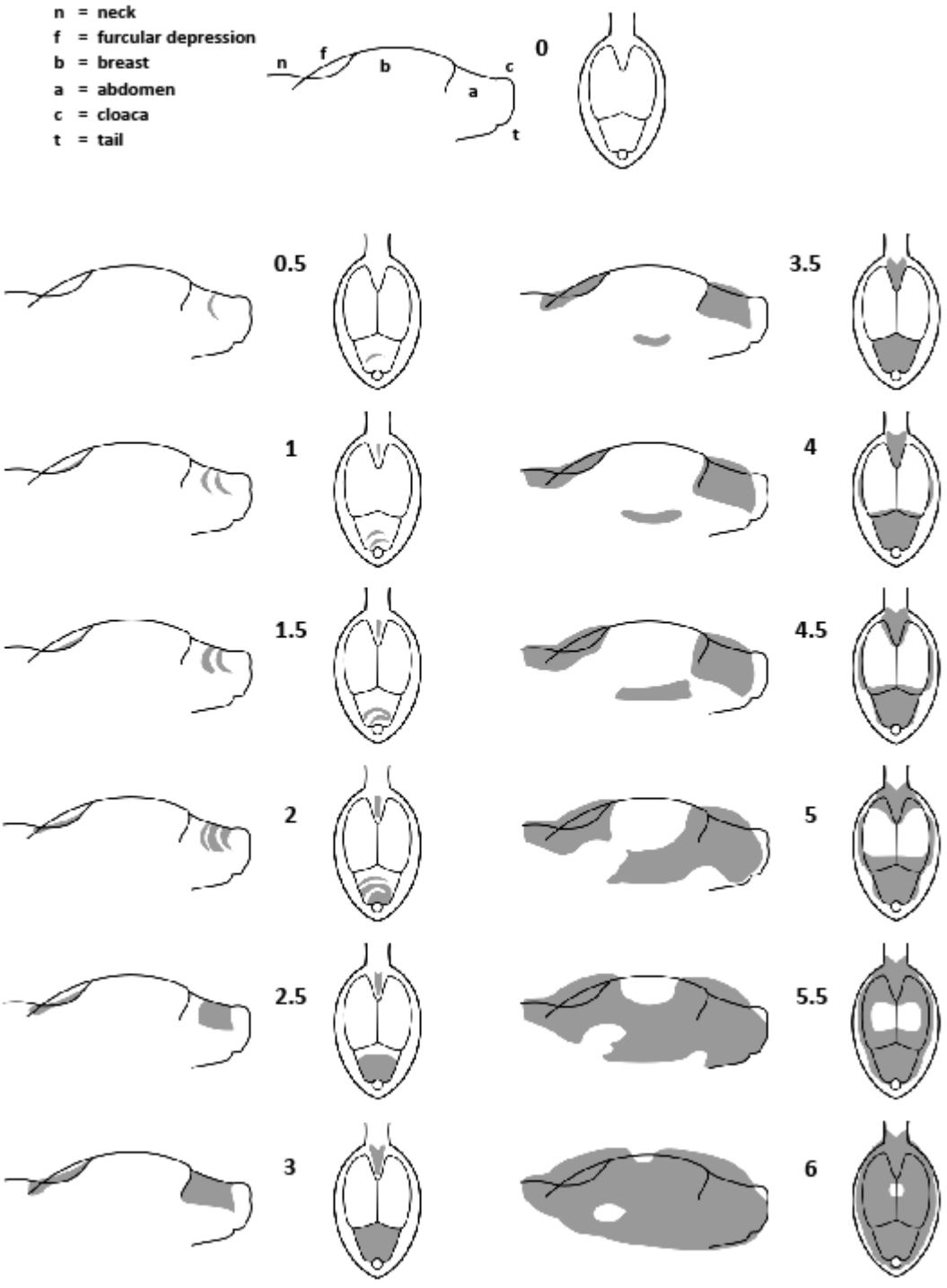


Figure 1. Visual representation of Helms & Drury (developed by Dr. Frank Moore, Univ. Southern Mississippi). Shaded areas represent fat deposits.

MAPS codes shown below should be used to record fat content if you use the MAPS method;
0.0 - No fat in the furculum or anywhere on the body.
1.0 - A very small amount of fat in the furcular hollow (< 5% filled) but not enough to cover the bottom of the furculum, and no fat or just a trace of fat is present under the wing, on the abdomen, or anywhere else on the body; **or**, if there is no fat in the furcular hollow, at least a trace of fat is present under the wing, on the abdomen, or both.
2.0 - The bottom of the furculum is completely covered but the furcular hollow is less than ⅓ filled, and a small amount of fat may be present under the wing, on the abdomen, or both; **or**, if there is no fat in the furcular hollow, a covering pad of fat is definitely present under the wingpit and, usually, on the abdomen.
3.0 - The furcular hollow is about half full (actually anywhere from ⅓ to ⅔ filled), and a covering pad of fat is definitely present under the wingpit and, usually, on the abdomen; **or**, if there is no fat in the furcular hollow, a thick layer of fat occurs under the wing and on the abdomen.
4.0 - The furcular hollow is full (actually anywhere from ⅔ full to level with the clavicles) and a thick layer of fat also occurs under the wing and on the abdomen; **or**, if the fat in the furcular hollow is not full, the fat under the wing as well as on the abdomen is well mounded.
5.0 - The furcular hollow is more than full; that is, the fat is bulging slightly above the furculum. The fat under the wing as well as that on the abdomen is also well mounded.
6.0 - Fat is bulging greatly above the furculum. Large mounds of fat occur under the wings and on the abdomen.
7.0 - The fat pads of the furculum, "wingpit," and abdomen are bulging to such an extent that they join. Nearly the entire ventral surface of the body is thus covered with fat, and fat even extends onto the neck and head.

SUPPLEMENTAL DATA FIELDS

Many of the following are taken from the MAPS manual. These fields are not required for the MMN but can add to the data proofing and/or add to the life history knowledge during the migration season. Always consider bird safety of the bird being examined and others waiting for processing prior to conducting these additional measurements.

Net - Enter up to a two-digit, numeric or alpha code (e.g. 06 or E) for the net site at which the bird was captured or recaptured. While supplying the net of capture is not mandatory, it will be required if the station can't meet standardization protocol requirements in net usage. Please leave blank if unknown.

Skull – (From MAPS manual) Skull Pneumatization. This should be used during **fall migration only**. In order to determine the degree of skull pneumatization, it is necessary to part the feathers of the head to get them out of the way (wetting them slightly may help), then gently rock the skin back and forth over the skull while looking through the skin to the skull. The best procedure is to start at the back of the skull and proceed toward the front looking for the pattern of the line that separates the pneumatized area from the area that is not pneumatized. A pneumatized skull consists of two layers of bone connected by tiny "struts" and filled with air, much like the wing

of a plane. A pneumatized skull appears opaque and grayish with tiny whitish dots. In contrast, an un-pneumatized skull, consisting of a single, thin layer of bone, appears pinkish and somewhat translucent and never shows the minute dots characteristic of a pneumatized skull. See Yunick 1979, Ralph *et al*. 1993, and Pyle 1997 for more complete information (including diagrams) on the determination of age by skull pneumatization.

Skull pneumatization should be recorded by means of the scale shown below.

0 - (none): Skull not pneumatized; that is, only a single thin layer of bone covers the entire brain, which shows through the thin covering of bone and appears as an unmarked, pinkish color. Beware of thick-skinned species such as Corvids and Parids, whose skull can be very difficult to see because the skin itself tends to be rather opaque; and heavily-muscled species such as grosbeaks and cardinals, whose jaw muscles can obscure the rear of the skull. Not likely during migration.

1 - (trace): A trace of skull pneumatization can be seen at the very back of the skull, usually appearing as an opaque, grayish crescent or a very-small, triangular area. Somewhere from 1 to 5% of the skull is pneumatized. Not likely during migration.

2 - (less than 1/3): Skull less than 1/3 pneumatized but some pneumatization is obvious. Thus, somewhere from 6 to 33% of the skull is pneumatized. Generally, the posterior part of the cranium has an inverted ‘u'- or ‘v'-shaped area of pneumatization that is usually distinctly grayish and contrasts with the unpneumatized area. The grayish area typically shows the characteristic, small, whitish dots of a pneumatized skull. Not likely during migration.

3 - (half): Skull greater than 1/3 but less than 2/3 pneumatized. In typical birds, most of the rear half of the skull is pneumatized, as is a small portion of the front part extending back around the eyes. This front part of the skull is usually very difficult to see because the feathers of the forehead are dense and short and difficult to move out of the way. In most cases, a bird given a “3” skull will show a pneumatized area extending up the midline or sides of the skull. Not likely during migration.

4 - (greater than 2/3): Skull at least 2/3 pneumatized but at least small areas of skull not pneumatized. Thus, somewhere from 67 to 94% of the skull is pneumatized. The un-pneumatized areas generally show either as two oval, pinkishspots on either side of the cranium or (rarely) as a single spot in the center of the skull.

5 - (almost complete): Somewhere from 95 to 99% of the skull is pneumatized. These birds have virtually a fully-pneumatized skull that shows one or two tiny, dull-pinkish areas where the pneumatization is incomplete. It should be noted that some birds, including many flycatchers, thrushes, and vireos, never develop a fully pneumatized skull, even when adult, but retain a “5” skull throughout life. Thus, a “5”-skull bird cannot necessarily be called a HY/SY bird because it could be an AHY/ASY bird whose skull never completely pneumatized.

6 - (fully complete): Skull fully pneumatized.

OPTIONAL DATA FIELDS

Body Molt -- (From MAPS manual) Be aware of bird safety of the present bird and birds awaiting processing before conducting this measurement. Additional efficiency of your operation can be made by only checking species known to molt in migration. Body molt should be determined by examining the bases of all the contour feathers on the bird’s body, including all

the body feathers as well as the upper and underwing coverts (both secondary coverts and primary coverts) and the upper- and undertail coverts. The bases of the feathers can be exposed by blowing lightly but continuously over the body and can be accomplished while obtaining a fat score. The presence of pinfeathers is a sure sign of the early stages of molt. Later stages can be recognized by a remnant, scaly sheath at the base of each growing feather. These sheaths persist until the feathers are fully grown. You should integrate several factors in making your rating, including the number of feather tracts in molt and the proportion of feathers in molt in each feather tract. Body molt should be rated according to the scale shown below.

0 - (none): No body molt. No feathers in sheath or growing.

1 - (trace): Only a very few feathers molting anywhere on the bird's body, usually in no discernible pattern.

2 - (light): A few feathers are molting from a few feather tracts, or some feathers(fewer than ½) are molting from only one tract. In general, fewer than ⅓ of the contour feathers on the bird are molting.

3 - (medium): Some feathers (generally fewer than ½) are molting from most tracts, or many feathers (generally more than ½) are molting from one tract or a few tracts. In general, from ⅓ to ⅔ of a birds contour feathers are in molt. This class also should be used for a bird in spring whose pre-alternate molt normally includes only the head but that has nearly all head feathers in molt. Such a bird would be given a class "3" even though fewer than ⅓ of all its contour feathers are molting.

4 - (heavy): Many feathers (generally more than ½) are molting from many or most tracts. In general, more than ⅔ of the contour feathers on the bird are in molt status.

FF Molt -- Flight-feather Molt. Flight feathers = primaries, secondaries, and rectrices. Most adult passerines in North America undergo a complete molt following the breeding season. This molt usually occurs from July to September and most often occurs on the breeding grounds, although there are some notable exceptions (see Pyle 1997). We refer to this complete molt in adults as the **prebasic molt** (= adult prebasic molt in Pyle 1997). At the same time of year (July to September), juvenile birds also undergo a molt which, following the new terminology of Howell *et al*. (2003), we refer to as the **preformative molt** (= first prebasic molt in Pyle 1997). In contrast to the complete prebasic molt of adults, the preformative molt in juveniles of most passerine species is partial; that is, it includes the body feathers but not the flight feathers, except sometimes the innermost rectrices and the innermost secondaries (the tertials). Thus, the presence or absence of symmetric flight-feather replacement in a bird undergoing molt in the late summer and early fall often provides another good indicator of the age of the bird. First, be sure to check Pyle (1997) to make sure that the species does not replace flight-feathers during the preformative molt (termed first prebasic molt in Pyle). Then, examine all the primaries, secondaries, and rectrices for the presence or absence of flight-feather molt; and examine both the left and right sides to be sure that the replacement is symmetric and not adventitious (the accidental, generally asymmetric, loss of flight feathers or body feathers anywhere on a bird). Record flight-feather molt with the codes shown below. In this case, we recommend using alpha codes since the codes are categorical and do not represent a sequence that can be expressed numerically.

N - (none): No flight-feather molt.

A - (adventitious): Accidental, adventitious, usually asymmetric flight-feather molt.

S - (symmetric): Normal, essentially symmetric flight-feather molt, indicative of prebasic molt in adult birds and preformative molt in some young birds. A few species also exhibit prealternate flight-feather molt (see Pyle 1997).

J - (juvenile growth): Growth of juvenile flight feathers in fledgling birds (only to be used for very young birds, just out of the nest, growing their first flight feathers). Not likely during the migration period.

IMPORTANT NOTE: If a bird is exhibiting flight-feather molt, record, as a note, the particular group(s) of feathers (primaries, secondaries, and/or rectrices) in which molt is occurring. If possible, record the highest-numbered growing feather in each molting group. This information will aid greatly in the verification of age data (eg. P1-3).

Molt Limits & Plumage – (From MAPS manual) These fields are to be used for adult birds aged more specifically than AHY (i.e., SY, ASY, TY, or ATY), as well as for any birds (including those aged HY or AHY) aged by molt limit or plumage (i.e. any time "L" or "P" is used as a how-aged code). Up to eight fields, which describe individual (or multiple) feather tracts or non-feathered body parts, may be considered for any individual bird. At least one of the first seven fields should be filled in if the bird is aged by molt limit or plumage, and at least one of the fields must be filled in if the bird is aged SY, ASY, TY, or ATY. Refer to Pyle (1997), Froehlich (2003), and Saracco (2004) for additional discussion and examples of the use of molt limits and plumage criteria for aging landbirds. Note that in Saracco (2004) and in the material that follows, we use the new molt terminology of Howell *et al*. (2003) as discussed by Pyle (2004). In particular, as compared to molt terminology in Pyle (1997), we use **formative feathers** instead of first basic feathers, **preformative molt** instead of first prebasic molt, **basic feathers** to mean adult basic feathers, and **prebasic molt** to mean adult prebasic molt. The eight MOLT LIMITS & PLUMAGE fields are:

Pri. Covs – Primary coverts.
Sec. Covs – Secondary coverts (i.e., greater, median, lesser, carpal, and alula coverts and alula).
Primaries – Primaries.
Seconds – Secondaries, not including the tertials.
Tertials – Tertials.
Rectrices – Rectrices.
Body Plumage – Includes all feather tracts of the head, upperparts and underparts (including the underwing coverts).
Non-Feather – Includes all non-feather parts including bill, mouth, eye, legs, and feet. The codes entered in these fields should reflect the ***feather generation(s)*** present within the particular feather tract (or multiple feather tracts in the case of body plumage). Adventitiously (accidentally) replaced feathers should be ignored (except to provide context to the other feathers in the tract) because recognizing them as a separate feather generation will lead to miss-aging birds. Similarly, brand new or actively molting feathers should be ignored when coding tracts containing actively molting feathers.

J – Juvenile: Feather tract comprised entirely of retained juvenile (or a mix of juvenile and alternate) feathers, but no formative (= first basic in Pyle 1997) feathers. This code should also be used for NON-FEATH if non-feathered body parts show characteristics indicative of a young bird. Not likely during migration periods.

L – Molt limit: Molt limit between juvenile and formative feathers exists **within** the feather tract, regardless of whether or not alternate feathers are also present in the tract.

F – Formative: Feather tract comprised entirely of formative (or a mix of formative and alternate) feathers, but no juvenile feathers.

B – Basic: Feather tract comprised entirely of basic (or a mix of basic and alternate) feathers (note that basic feathers = adult basic feathers in Pyle 1997), but no juvenile or formative feathers. Individuals of some near-passerine species (e.g., woodpeckers) can be aged to TY or ATY due to incomplete molts, which result in feathers that are retained through the next prebasic (not preformative) molt. Such individuals can have up to three generations of juvenile and basic feathers present within the same feather tract (these species do not acquire alternate feathers).

M – Mixed: Multiple generations of basic feathers are present in the tract (e.g. see Fig. 27 in Froehlich 2003).

A – Alternate: **ALL** feathers in the feather tract are of alternate plumage; if **ANY** juvenile, formative, or basic feathers are present, the alternate feathers should be ignored and the code for the feather tract should be based on the other feathers, that is J, L, F, or B.

N – Non-juvenile: Feathers in this tract are definitely not juvenile feathers (or the non-feathered body part is not characteristic of a young bird), but whether or not they are formative or basic feathers cannot be determined with confidence. Note that if primary coverts are coded J and a molt limit exists between the primary coverts and the secondary coverts, the secondary coverts must be formative feathers and, thus, must be coded F, not N, even though formative and basic secondary coverts might be indistinguishable from each other. The code N should only be used as a last resort; every effort should be made to identify appropriate feather tracts to formative or basic. Often, this is best accomplished by considering the tract in the context of other tracts which, for example, have perhaps been reliably aged juvenile. This code should also be used for NON-FEATH if non-feathered body parts show characteristics indicative of an adult bird.

The following code should be used for feather tracts examined, but not meeting any of the above criteria:

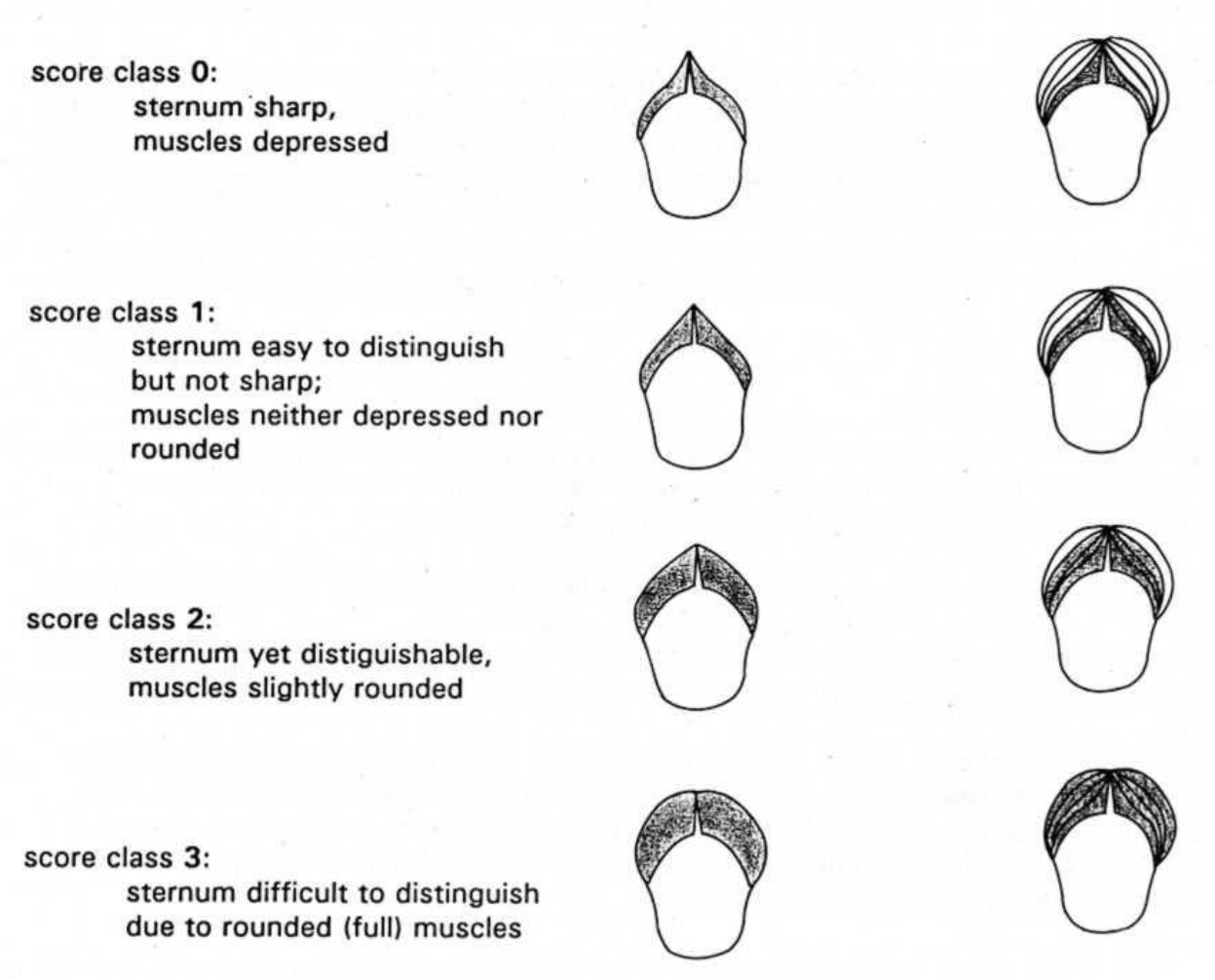
U – Unknown: This code should be used for any feather tract or non-feathered body part that is examined, but that shows ambiguous characteristics or that cannot be coded with confidence.

Finally, LEAVE BLANK any field representing a feather tract or non-feathered body part that was not examined for any reason, including cases where that feather tract provides no useful information for ageing the bird. As an example of the use of these fields, consider the age determination of a SY bird (i.e., AGE = 5) prior to its prebasic molt. The age of SY birds can be determined by the retention of juvenile feathers, which will be evident in some feather tracts but not others (depending on the extent of the preformative molt). Any feather tract for which retained juvenile feathers are evident will have either a "J" or "L" entered in its field, depending on whether molt limits are between or within feather tracts, respectively. If the molt limit is between feather tracts, the tract with juvenile feathers would be coded "J" and the tract with formative feathers would be coded "F." If the molt limit is within the feather tract, the tract would be coded "L." In each of these cases where a molt limit between juvenile and formative feathers can be discerned, the bird should be aged by molt limit (HOW AGED = L). If, however, a molt limit cannot be discerned, but the juvenile feathers present can be distinguished as

juvenile (as opposed to basic) feathers by their appearance alone (i.e., color, shape, quality, or wear), the bird would be aged by plumage (HOW AGED = P). Remember, any feather tract or non-feathered body part that was examined, but for which a code could not be determined, should have a “U” entered in its field. As another example, consider an ASY bird (i.e., AGE = 6) prior to its prebasic molt. Birds of this age are typically distinguished by having undergone a complete prebasic molt – adjacent feather tracts generally show little if any contrast in quality or wear. Such birds should have a “B” entered in all fields for which the basic feathers present can be distinguished as basic (as opposed to juvenile) feathers by their appearance alone (i.e., color, shape, quality, or wear), and should be aged by plumage (HOW AGED = P). They should not be aged by molt limit (HOW AGED = L) because there is no molt limit. Note that any alternate feathers present provide no information as to whether the individual is a SY or ASY bird.
As a third example, consider a species that can undergo a complete preformative molt (e.g., a Northern Cardinal). When examining an adult of these species during the breeding season, you may find that all of the feathers are of a single generation (i.e., no molt limits). Because formative and basic feathers appear identical in this species, you will not be able to age the bird specifically to SY or ASY and so the bird must be aged AHY (i.e., AGE = 1). Such birds should have “N” entered in all fields for which the formative or basic feathers present can be distinguished as non-juvenile feathers by their appearance alone (i.e., color, shape, quality, or wear), and should be aged by plumage (HOW AGED = P). If a molt limit is present in these species, the limit must be between juvenile and formative feathers and "N" should not be used in any field because evidence for the existence of formative feathers is provided in context by the presence of juvenile feathers. Therefore, the bird must be aged SY (AGE = 5). Birds of these species can never be aged ASY (AGE = 6) in the field.

Finally, it is possible that various feather tracts in an individual bird will show conflicting characteristics (i.e., characteristics that indicate different age classes). When making an age determination for such a bird, give more weight to tracts that are more reliable or have the most obvious reliable features. Although it is not necessary that all tracts in a record agree, you should be confident in your ultimate age designation. During the MMN season, a bird with no reliable feather tracts or a bird for which conflicting characteristics make age determination difficult should be aged as AHY prior to the prebasic molt (AGE = 1) and as indeterminable (AGE = 0) after the prebasic (or preformative) molt.

Muscle Score - Beside fat which is the primary energy fuel for migrating birds, migrants also use muscle proteins in flight. The size of the breast muscle is a further valuable indicator for body condition in migrants. In birds whose flight muscles are not covered by fat the shape of the breast muscles can be easily recorded and scored. Muscle score is assessed visually and by sweeping your thumb over the sternum.



Drawings by Göran Walinder, Falsterbo B.O., based on studies on live birds trapped for ringing and a few dissected ones.
Adapted from: European-African Songbird Migration Network. Bairlein et al.1995. Page 18.

Remarks – Use the comment section of the individual banding or recapture record in BANDIT to supply additional information. If the comment pertains to the station operation, it should be recorded in the effort information.

Feather Pull – Prior permission from the BBL is required to pull feathers. Ensure the authorization is on your banding permit before participating in projects requiring this operation.

Swab -- Prior permission from the BBL is required to take cloacal swabs. Ensure the authorization is on your banding permit before participating in projects requiring this operation.

COLLECTION AND RECORDING OF POINT COUNT DATA

Point counts are widely used in avian observational field research. Point counts are similar to transects but have the advantage of being easily incorporated into a formal study design (Bibby

et al.1992). While not requiring the skills needed in the banding operation, surveyors still need a high level of observer skill. In the context of migration monitoring, observational data has the added complexity of potential significant bird movement into and out of the point count area. The potential of large bird numbers can complicate the observations but is standardized by the set or determined time restrictions. Point counts are additive to the banding methodology as they will register species that banding is not designed for, such as larger, harder to hold species and diurnal migrants such as Corvids, blackbirds, and larger species such as waterfowl and raptors.

Point counts are to be placed within the banding station footprint of the mist nets for Level 1 and 2 stations. Level 3 stations do not have any restrictions except selecting a number that can feasibly be conducted in a morning. To be comparable to Level 1 and 2, Level 3 stations should plan on field counting to not exceed two hours in length. At least 100 meters should separate any two points. It is recommended that at least three points be conducted to improve statistical analysis. All birds seen and heard are to be recorded utilizing the attached form or a personalized form that provides the required fields. At this time, distance sampling is not included in this protocol and may be an addition as these protocols are reviewed. Presently, field work is being conducted to quantify the visibility changes inherent with migrational time frames. Unlike breeding situations, the vegetation changes throughout the spring and fall time periods. This affects visibility and the ability to see birds. If the ongoing research proves to be useful in addressing this variable, it will be included in point count protocols.

The main MMN objectives such as migrational temporal and spatial patterns can benefit from the point count data in model development. Level 3 contributors will add to the geographic distribution of the Network and increase information on potential sites and habitats in need of more study.

GENERAL PROCEDURES FOR RECORDING POINT COUNT DATA

Each MMN station is requested to conduct a series of point counts each day of operation.

Station Code – Provide the station code to the data entry form.

Point Count Array – Points are to be established by the station manager throughout the banding station for Level 1 and 2 or in a chosen habitat block for Level 3 stations. Each point should be a minimum of 100 meters apart to reduce double counting.

Point Count Time – Point counts should be initiated after net set up and should coincide near sunrise. Each point should be conducted for 5 minutes. Individual stations may have existing counts of differing times but are requested to subset to this 5 minute standard. It is preferred to have twice the number of 5 minute counts than half the number of 10 minute counts for analysis purposes.

Date – The date of the survey is to be completed using month-day-year configuration (ex. 053017).

Observer – The name of the observer should be recorded for each count.

Point Code – Points may use numeric or alpha codes (eg. A or 3).

Point Time – Record the time at the start of the point. End time will be 5 minutes later and does not need to be recorded unless a situation results in a forced suspension of the point recording. This could represent a problem at a net that needs to be attended to for bird safety purposes or a sudden weather event.

What to Count – All species seen or heard are to be counted during the active time frames. This can become quite complex on major movement days. Because of this potential it is accepted that some individuals will be recorded as unknown species. While an unknown bird has little usefulness, unknown sparrow or unknown warbler can be used in many analyses of different questions. The BBL four-letter codes are to be used for identified species. Appendix 2, Table 1 provides codes for unknown species.

Weather – Comments should be recorded on weather conditions during the count. Wind speed (Beaufort scale) and direction, precipitation, noise, and cloud cover are examples that should be recorded.

Data Entry - Data will be entered through the provided form for the MWADC portal or can be downloaded to the portal once the MMN is verified that the interface will work for your source data.

COLLECTION AND RECORDING OF DAILY LIST DATA

The third data stream from the MMN is the daily list. This is the least qualitative yet most quantitative of the data collected. It is a presence/absence record of birdlife on the site for that given day and time period. The list compliments the banding and point count data by indicating the list of species known to be present that day. It assist in developing bounds of migrational timing by species and records species that were not captured or reported on the systematic point count but were in fact present. Rare species information is greatly augmented by the list.

GENERAL PROCEDURES FOR RECORDING DAILY LIST DATA

Check List – A local, regional, or state check list can be used for recording sightings throughout the field work day. All station personnel are part of completing the daily list. This can be beneficial in keeping all personnel engaged in the project even in slow times.

Time – Species are recorded as present throughout the time the station is open or a Level 3 station is conducting point counts. Counting should cease within 60 minutes of net closure.

Data Entry – All checklists will be entered into an excel spreadsheet. A template can be downloaded from the MMN. Each observed species will be given a "1" for each day it is recorded. The Station Code will be located in the A1 cell.

DATA SUBMISSION

Making sure the required data from each station become a part of the compiled MMN database is the final, and most crucial, step in operating a MMN station. To maximize the use that can be made of the data, all elements listed below must be included. It is also important to ensure that data submission occurs within a reasonable amount of time; delays hold up analyses, prevent us from providing you with timely feedback, and require us to spend time rounding up outstanding data.

What Data To Submit

Each year, for each location, MMN operators must submit the following data:
- Banding data for newly banded birds to BBL
- Banding data for recaptured birds to BBL
- Summary of mist-netting effort data for each station to MWADC
- Summary of mist-netting results data for each station to MWADC
- Point count data to MWADC
- List count data to MWADC
- Habitat Structure Assessment (HSA) data (including the station map) must also be submitted for each station during its first year of operation and every five years following (i.e., sixth year, eleventh year, etc.) to MWADC. A revised map should be submitted after any major change in habitat or net locations.

How To Submit MMN Data

Data will be submitted to the MMN program in two ways: Banding and recapture data electronically to the Bird Banding Laboratory and effort and station metadata electronically to the Midwest Avian Data Center.

SUBMITTING DATA THROUGH BBL: Presently, banders in North America submit banding data to the Bird Banding Laboratory in the U.S. and the Bird Banding Office in Canada. Beginning in 2016 data is to reported using the Bandit 4.0 program supplied by the BBL. The BBL is expecting to institute changes in 2018 that will include all data fields requested by MAPS and MMN. Recapture data is now being accepted by the BBL and all MMN data should be submitted to the BBL.

SUBMITTING DATA THROUGH MWADC: The MMN is developing a data entry portal for all datasets pertaining to station operations and seasonal effort data. Completion of the station registration will complete many of these requirements. Seasonal effort data can be uploaded or entered directly into the Midwest Data Center.

Due Date

MMN operators are requested to enter their completed metadata and effort data sheets to the MWADC as soon as possible after the completion of the season. In general, the due dates are spring migration July 15 and fall migration December 15.

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Appendix 1.

Target Species of the Midwest Migration Network.

American Woodcock	No. Saw-whet Owl	Black-billed Cuckoo	Yellow-bellied Sapsucker
Red-headed Woodpecker	Eastern Whip-poor-will	Olive-sided Flycatcher	Bobolink
Eastern Meadowlark	Rusty Blackbird	Henslow's Sparrow	White-throated Sparrow
Lincoln's Sparrow	Blue-winged Warbler	Golden-winged Warbler	Nashville Warbler
Tennessee Warbler	Black-throat.-blue Warbler	Myrtle Warbler	Magnolia Warbler
Cerulean Warbler	Blackpoll Warbler	Kirtland's Warbler	Ovenbird
Kentucky Warbler	Connecticut Warbler	Mourning Warbler	Canada Warbler
American Redstart	Wood Thrush	Gray-cheeked Thrush	Swainson's Thrush

Appendix 2.

Table 1. Four-letter codes for unknown species that are not included in the BBL codes.

Unknown Duck	UNDU
Unknown Shorebird	UNSH
Unknown Hawk	UNHA
Unknown Raptor	UNRA
Unknown Flycatcher	UNFL
Unknown Kingbird	UNKI
Unknown Finch	UNFI
Unknown Sparrow	UNSP
Unknown Vireo	UNVI
Unknown Warbler	UNWA
Unknown Thrush	UNTH

This table is an active table and more unknown species can be added.

Figures to be added soon.

Figure 1. Registration Form

Figure 2. Habitat Structure Assessment Form

Figure 3. Point Count Form

Figure 4. Daily List Form

Figure 5. Effort Data

Figure 6. Banding Form

Figure 7. Recapture Form