Regional Protocol for Surveying Breeding Landbirds on Wildlife Refuges

with the Integrated Monitoring in Bird Conservation Regions Program

Version 1.3   November 2019

ON THE COVER
MacGillivray's Warbler
Photograph by Glenn Giroir

NWRS Survey Protocol Signature Page

Protocol Title:	**Regional Protocol for Surveying Breeding Landbirds on Wildlife Refuges** *with the Integrated Monitoring in Bird Conservation Regions Program*

Version[1] : 1.3

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Approvals	

Action	Appropriate Signature/Name	Date
Survey Coordinator[2] Submitted by:		
Zone I&M[3] or equivalent Approval:		
Regional I&M[4] Approval:		
National I&M[5] Approval:	Jana Newman, I&M Program Manager	

Version[1]	Date	Author	Change Made	Reason for Change

[1] Version is a decimal number with the number left of decimal place indicating the number of times this protocol has been approved (e.g., first approved version is 1.0.; prior to first approval all versions are 0.*x*; after first approval, all minor changes are indicated as version 1. *x* until the second approval and signature, which establishes version 2.0, and so on).

[2] Signature of station representative designated lead in development of a site-specific survey protocol.

[3] Signature signifies approval of a site-specific survey protocol.

[4] Signature by Regional I&M Coordinator signifies approval of a protocol framework to be used at multiple stations within a Region.

[5] Signature by National I&M Coordinator signifies approval of a protocol used at multiple stations from two or more Regions.

Survey Protocol Summary

This protocol framework is adapted from "Integrated Monitoring in Bird Conservation Regions" (IMBCR), a landbird monitoring program developed by Rocky Mountain Bird Observatory (now Bird Conservancy of the Rockies), U.S. Forest Service Rocky Mountain Region, and Colorado Parks and Wildlife. The IMBCR survey protocol has been adopted and implemented by multiple state and federal agencies in all or parts of the 12 states that comprise U.S. Fish and Wildlife Service (USFWS) Southwest and Mountain-Prairie Regions. This protocol works best for breeding landbirds, especially songbirds and more common raptors, game birds, and shorebirds.

Landbird surveys can be used to produce estimates of density and occupancy (inventory) and to measure changes in these population parameters through time (monitoring). The purpose of this protocol framework is to guide USFWS personnel in conducting site-specific landbird monitoring for individual refuges currently within the Mountain-Prairie and Southwest Regions, and small portions of the Pacific and Pacific Southwest Regions. Objectives of the protocol framework include: (1) establishing a consistent, probabilistic sampling design across refuges; (2) establishing consistent, robust field sampling methods across refuges; and (3) ensuring that data collected are compatible with other landbird monitoring data in these regions.

The sampling design consists of selecting a spatially balanced sample of 1-km^2 sampling units, each of which contains 16 sampling points. Surveys will be conducted on 10-30 sampling units within each refuge but there is flexibility with sampling design and effort depending on the refuge size and biologists' objectives. Inference about bird populations can be made to the entire refuge or to select parts of a refuge, depending on objectives. Field methods follow commonly accepted practices and consist of recording the distance to each bird detected during 6-minute surveys at each sampling point. Field observers record the species, sex, detection method, and other ancillary information for each bird detected. Observers must be able to identify all breeding bird species at a refuge by both sight and sound and accurately record distance to each detection. Consequently, field observers should be highly skilled at bird identification and should be trained in distance estimation prior to conducting landbird surveys. Field observers also collect data to describe the habitat at each sampling point, such as overstory and understory cover by species.

By participating in the IMBCR program, refuges will benefit from established protocols for data collection, data entry, and data quality control. Refuges will also receive annual reports summarizing the previous field season with access to raw and analyzed data. Finally, the hierarchical design of IMBCR provides context for population estimates both within and across regions, and estimates of occupancy or abundance at the refuge scale will benefit from estimates of imperfect detection derived from data collected at a larger regional scale.

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Acknowledgments

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Narrative

Element 1: Introduction
In "Conserving the Future: Wildlife Refuges and the Next Generation" (USFWS; 2011), the US Fish and Wildlife Service articulated a vision for the future of the National Wildlife Refuge System. The vision included a commitment to science, recommendations for inventory and monitoring of wildlife and habitats, and a desire to coordinate research and monitoring with partners beyond the Refuge System.

This protocol framework provides detailed guidelines for any refuge to develop a scientifically rigorous plan for inventorying and monitoring breeding landbirds. The framework follows the sampling design and methods used throughout the USFWS Southwest, Mountain-Prairie, Pacific, and Pacific Southwest Regions by numerous state and federal agencies and non-governmental organizations. The format of this framework follows that suggested by the USFWS Survey Protocol Handbook, whereby the protocol narrative provides an overview of the landbird monitoring framework and the standard operating procedures (SOPs) provide detailed instructions for implementing the landbird monitoring program.

Background
Reliable information about the status and trends of wildlife populations is essential to informed management of National Wildlife Refuges. Birds in particular can be excellent indicators of biological integrity and ecosystem health (Morrison 1986, Hutto 1998, O'Connell et al. 2000, Rich 2002). Because they comprise a diverse group of niche specialists, occupy a broad range of habitats, are sensitive to both physical and chemical impacts on the environment, and often reflect the abundance and diversity of other organisms with which they coexist, birds can be useful barometers for environmental change and measuring the sustainability of human activities on ecosystems. Avian population parameters can be used to establish baseline conditions, assess population responses to management actions, evaluate progress toward management objectives, and validate assumptions about bird-habitat relationships. Inventory and monitoring of priority resources is a critical component of Strategic Habitat Conservation (National Ecological Assessment Team 2006).

A variety of parameters could be measured to monitor avian populations, including demographic rates (e.g., survival and reproduction) and population status (e.g., density and occupancy). This protocol framework is designed to estimate density and occupancy. However, it should be noted that the study design can be used to measure additional parameters, including demographic rates, environmental covariates, and even population parameters of additional species.

All methods for monitoring wildlife populations should incorporate the estimation of detection probability. Nichols et al. (2009) provides a thorough summary of state-of-the-art methods for estimating landbird abundance. Well-established methods for estimating detection probability from bird count data include distance sampling (Buckland et al. 2001), double observer sampling (Nichols et al. 2000), removal-in-time (Farnsworth et al. 2002) and repeat presence-absence surveys or point counts (Royle and Nichols 2003).

Some landbird species naturally occur at such low densities that estimating their abundances is not possible, or precision of abundance estimates is too poor to be useful for monitoring their populations through time. For these species, monitoring may be best achieved by measuring the proportion of sample plots occupied. The recent development of occupancy modeling theory and analytical methods has provided an alternative to estimation of density while incorporating estimation of detection probability (MacKenzie et al. 2002, 2006).

Nichols et al. (2008) developed a multi-scale occupancy model that relied on several detection methods. Pavlacky et al. (2012) extended this model to estimate occupancy at two spatial scales corresponding to territory occupancy and regional occupancy. The method of Pavlacky et al. (2012) is part of the Integrated Monitoring in Bird Conservation Regions (IMBCR) program design and described in this protocol framework.

Objectives
This landbird protocol framework can be used to produce estimates of bird density and occupancy (inventory) and to measure changes in these population parameters over time (monitoring) at local and regional scales. This protocol framework is intended to guide personnel in developing site-specific landbird monitoring programs for individual refuges within the Mountain-Prairie and Southwest Regions and some refuges in the Pacific and Southwest Pacific Regions (Fig. 1), but can be used in refuges outside of these regions. Objectives of the protocol framework include: (1) establishing a consistent, probabilistic sampling design across refuges or within management units on a refuge; (2) establishing consistent, robust field sampling methods across refuges; and (3) ensuring that data collected are compatible with other landbird monitoring data in these regions.

Who Will Use This Protocol Framework?
This protocol framework will be used by refuge biologists and field technicians to survey breeding landbirds on individual refuges. Information contained in this protocol on sampling design, data analysis, and reporting are meant to provide background information for refuge staff. It is intended for refuge biologists to contract Bird Conservancy of the Rockies (hereafter, Bird Conservancy) to assist with these steps, where refuge staff will carry out data collection, entry, and verification. However, if a refuge would like assistance with data collection, entry, or verification, an agreement can be reached with Bird Conservancy to complete the work. Bird Conservancy staff could also help train refuge staff on sampling design, additional analyses, and other tasks that refuge staff are capable of conducting on their own with some instruction. If a refuge biologist has questions about conducting landbird surveys on their refuge, they should contact the Bird Conservancy primary contact, Jennifer Timmer (Jennifer.timmer@birdconservancy.org). See Figure 1 for the current extent of the IMBCR program. Participating in this protocol would be most valuable to refuges located within the IMBCR footprint for providing context of bird populations (this includes much of the USFWS Southwest, Mountain-Prairie, Pacific, and Pacific Southwest Regions). For example, a refuge located in Montana could compare bird density or occupancy on their refuge to state-wide estimates or to the Badlands and Prairies Bird Conservation Region or to just the Montana portion of this Bird Conservation Region (Fig. 1). A refuge biologist could also determine what proportion of the regional bird population resides on his or her refuge during the breeding season for conservation responsibility.
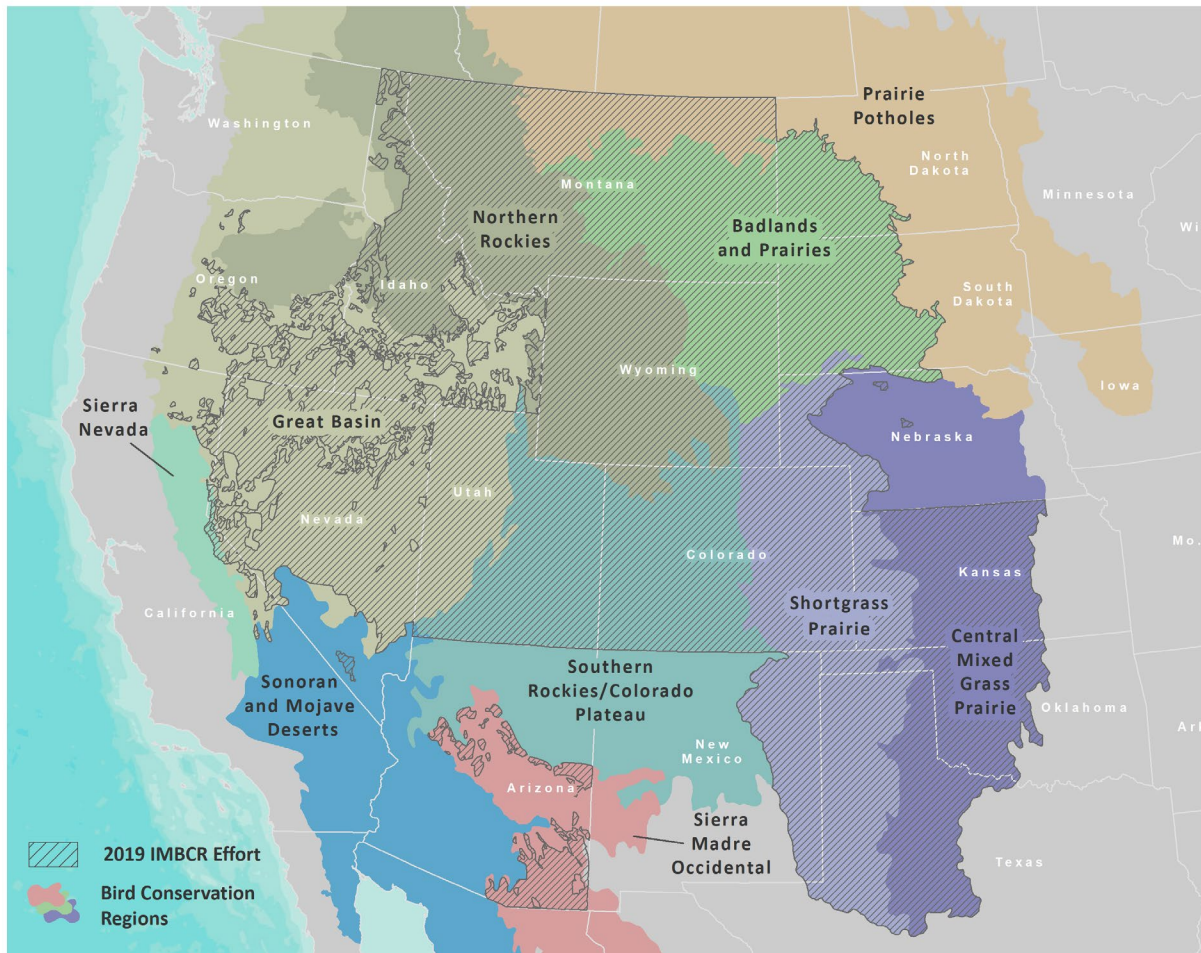
Figure 1. Geographic extent of the Integrated Monitoring in Bird Conservation Regions (IMBCR) program as of 2019.

Element 2: Sampling Design

A landbird monitoring program titled "Integrated Monitoring in Bird Conservation Regions" (IMBCR), has been adopted and implemented by multiple state and federal agencies in all or parts of the 12 states in the Southwest and Mountain-Prairie Regions (Pavlacky et al. 2017, Woiderski et al. 2018). IMBCR was developed by Rocky Mountain Bird Observatory (now Bird Conservancy), US Forest Service Rocky Mountain Region and Colorado Parks and Wildlife personnel with consideration of state-of-the-art sampling and analytical methods. The sampling design in this document is based on the IMBCR framework. Refer to *SOP 1: Sampling Design* for more details on sampling design and sample unit selection. Sample design and sample unit selection will most likely be conducted by Bird Conservancy personnel experienced in Geographic Information Systems (GIS) and familiar with the IMBCR sampling design. They will work with each refuge biologist to determine the sampling frame or area to which the biologist wishes to make inference about bird populations (this could be the entire refuge or just certain areas within the refuge). However, Bird Conservancy staff can work with refuge staff to provide guidance on sample design and sample unit selection if a refuge wishes to conduct these tasks for future monitoring efforts.

Sample design

A key element of the IMBCR design is its hierarchical framework: using *a priori* nested stratification, data collected at the local scale (e.g., within a management unit contribute to estimates and inferences at larger spatial scales (e.g., a Bird Conservation Region [http://www.nabci-us.org/bcrs.htm] or State). Conversely, data collected at larger spatial scales can contribute to estimates and inferences at smaller scales, primarily by improving estimates of detection probability. By following the protocol in this document, participating refuges can benefit from the work, tools and analytical expertise of the IMBCR program.

Stratification

In cases where innately similar sampling units are considered together as a stratum, a stratified sampling design increases sampling efficiency and precision (Thompson 2002). Strata, or areas to which inferences about bird populations are made, are based on fixed attributes, such as management boundaries. It is not recommended to base stratification on dynamic features, such as seral stages of vegetation communities. However, we can base stratification on major soil types, ecological sites, or other relatively static geomorphic features, which could be a surrogate for vegetation communities. If there is a part of the refuge to which a biologist doesn't wish to make inference to (e.g., body of water), it can be excluded from the sampling area. Inference about bird populations will be made either to the entire refuge or parts of the refuge (e.g., management unit) if certain areas of the refuge are excluded from sampling (e.g., inaccessible sites).

Each refuge will be designated its own stratum (Figure SOP 1.1). If the refuge is stratified by ecological type or other features, the individual strata will together comprise the "superstratum" of the entire refuge. Data obtained from refuges can be pooled with data from other strata across the IMBCR program to increase the precision of population estimates and increase the number of species for which robust analyses are possible. Estimates from refuges can also be compared to local or regional IMBCR population estimates for context.

Sampling units, sample frame, and target universe

The target universe is the population to which you want to make inferences. In the context of wildlife monitoring, the target universe includes both the organisms and the geographic area of interest. The target universe may be, for example "all diurnal landbirds on _____ National Wildlife Refuge during the breeding season." As another example, for a refuge composed of a mix of ponds and uplands, inferences may be restricted to uplands, in which case the target universe may be "all diurnal landbirds in upland portions of _____ National Wildlife Refuge during the breeding season." For long-term monitoring, it is important that the target universe remains fixed each year, otherwise, parameter estimates (e.g., density of a particular bird species) will not be comparable among years. If a refuge contains an area with restricted access that would prevent the area from being surveyed for landbirds, a decision may be made to exclude such an area from the target universe. Note that this will preclude any inferences about landbird populations on the excluded area.

Sample selection and size

Sampling units (referred to interchangeably as grids or transects) within the target universe will consist of 1-km^2 grids, each containing 16 evenly spaced sampling points (Figure SOP 2.2). The geographical sampling frame is composed of all potential sampling units in the geographical

target universe (e.g., a refuge; Figure SOP 1.1). This protocol will likely work best for refuges $\geq 10 \text{km}^2$ in size to ensure adequate sampling effort, but smaller refuges interested in conducting bird monitoring are encouraged to reach out to the primary contact with Bird Conservancy (jennifer.timmer@birdconservancy.org) to discuss it.

For each refuge, sampling units will be selected using Generalized Random-Tessellation Stratification (GRTS), a spatially balanced sampling algorithm (Stevens and Olsen 2004). Details of the GRTS design and how it works to achieve spatial balance are provided by Stevens and Olsen (2004). The GRTS design uses a hierarchical randomization process to achieve spatial balance across the region and the resource. A stratum boundary (e.g., a refuge) is laid on top of a grid (such as the US National Grid) and the area within a stratum boundary is subdivided until there is only one sample unit per cell. Cell addresses are assigned via a hierarchical random process, and each sample unit is assigned to its corresponding cell address, creating a linear sequence of sample unit cell addresses. By reversing the order of address digits and re-sorting this sequence, a systematic sample can be drawn with a random start point that maintains the spatial balance of the sample. GRTS orders all of the sampling units in the sampling frame such that any set of consecutively numbered sampling units is a spatially balanced sample (Figure SOP 1.3). This property allows for adjusting the sampling effort among years if necessary while maintaining a random, spatially balanced sample. Refuge staff may also select their own sampling units if they have used the GRTS design or receive instruction from Bird Conservancy staff.

Sources of error
The greatest potential source of error is the misidentification of bird species. Consequently, it is imperative that surveys be conducted only by individuals who are able to identify by sight and sound all birds that may be encountered in the refuge to be surveyed. Other sources of error include incorrectly recording distances from sample points to detected birds and the minute interval during which each bird is detected. These data are used to estimate detection probabilities using distance and occupancy modeling frameworks, respectively. Any errors in estimated detection probabilities would result in erroneous estimates of density and/or occupancy.

In addition to errors, biases may arise if areas to be surveyed are not selected based on a probability sampling algorithm, such as the spatially balanced sampling designs of this monitoring framework. For example, if surveys are only conducted along roadsides, inferences will be limited to roadsides within the refuge. It would be invalid to assume that results from roadside surveys accurately reflect conditions within the entire refuge.

Element 3: Field Methods and Processing of Collected Materials
Pre-survey logistics and preparation
Preparation for the field season begins several months before conducting the actual surveys. Confirming sites, preparing maps, and contacting data collectors all must be done well in advance of the field season. Setting up the sampling frame and selected grids for each refuge must also be done the fall or winter prior to surveying, the specific tasks of which are detailed in SOP 1.

Prior to each field season, observers should read the entire protocol narrative and all SOPs in this protocol. Observers should pay special attention to the tasks described in SOPs 1 and 2. Practice and training in identifying birds by sight and sound is critical. The misidentification of a species is the most serious error one can make during breeding bird counts (Kepler and Scott 1981, Royle and Link 2006). All equipment and supplies listed in SOP 2 should be organized and made ready for the field season.

Weather-related interruptions during scheduled surveys may occur in any of the refuges. Therefore, unpredictable weather, as well as staff workloads, requires maintaining flexibility in scheduling the sequence and duration of sampling events during the field season.

Overview of point count surveys
We will use the point count survey method to estimate and monitor landbird population parameters (Buckland et al. 2001). Point count surveys entail estimating the distance from an observer to detected object (e.g., bird) from a fixed location, which is also known as distance sampling (Buckland et al. 2001). Point count surveys can also include temporal replication in a removal design, in which detections are binned in minute intervals when first detected. Our use of distance sampling and a removal design will provide population estimates (i.e., density and occupancy) that are comparable both within and among refuges, and will also facilitate comparisons with data from other locations in North America where the same survey methods are used (Pavlacky et al. 2017).

Data collection procedures
Data collection follows strict guidelines detailed in *SOP 2: Conducting Surveys*. These are procedures for collecting data in the field.

Seasonal timing of surveys
We will focus our survey efforts during the breeding season when increased territorial behavior by songbirds results in higher detection rates and greater sampling efficiency.

Surveys will coincide with the breeding season for the greatest number of species in each refuge, recognizing that some species may not be adequately surveyed because of later arrival dates or early breeding activity. For this monitoring effort, we will attempt to time surveys similarly each year because a shift in survey timing could bias trend estimates. To ensure that surveys are clustered around the time of peak breeding activity for each refuge, we will survey once annually according to the general survey windows listed in Table SOP 2.1, which are based on annual timing of breeding within each state or region. It is important to recognize that this window may shift in the coming decades, making it necessary to adjust the protocol (Brown et al. 1999). There is also some flexibility in frequency of surveys if a refuge is interested in a panel design or conducting landbird surveys every other year. They should contact their primary contact at Bird Conservancy to discuss these options as needed.

Field protocol
Point count surveys will be the primary field method and will make up the bulk of the effort during the field season. The daily field schedule for each surveyor will involve visiting up to 16 points each day (minimum of six points) in a 1-km^2 grid. The bird sampling crew should arrive at the survey area on the afternoon prior to the first day of sampling to familiarize themselves with

the area and the birds present. If the area being surveyed is too far from a road, campsite, or trailhead to be reached in 30 minutes of hiking, every effort should be made to camp near the site on the night prior to scheduled surveys. Bird surveys will begin approximately 30 minutes before local sunrise. More information on the bird survey protocol can be found in SOP 2. For bird surveys, observers should review datasheets for completeness and readability prior to leaving the field each day. The refuge biologist or other designated staff is responsible for the safekeeping and organization of datasheets, and for ensuring that data are entered into the database.

Conducting bird surveys
Details on how to conduct point-transect surveys, and for filling in datasheets, are provided in *SOP 2: Conducting Surveys* and summarized here. All birds seen or heard at each point are recorded during a six-minute sampling period. We will separate bird observations into minute-long time segments to allow comparisons with the Breeding Bird Survey and other monitoring efforts, and for use in other analytical applications such as removal sampling (e.g., Farnsworth et al. 2002, Pavlacky et al. 2012). We will record all birds, regardless of detection distance from the surveyor, and note sex and age when possible. For most species, we will record each individual bird as a separate observation unless groups of birds are observed at the same distance, in which case the flock or group size will be noted. We will record any bird flying over a point without showing any signs of using the surrounding habitat as a "flyover," with a designation of "F" in the how detected category.

While conducting counts, observers should focus primarily on birds that are close to the point. Although all detected birds should be recorded, distant birds have little effect on density estimates while missing close birds can have a significant effect on density estimates. Once a point count is completed, observers locate successive points with the use of a GPS. While walking from one point to the next, observers should record species not yet detected during surveys or that are not currently on the species list for the refuge being surveyed. These species are considered "incidental" observations and should be recorded separately on the datasheet (see *SOP 2: Conducting Surveys*). These data allow for a more complete record of species in an area and are especially important for rarer species that may not be detected during an actual survey at a point count location.

Establishing and marking points
Survey points do not need to be permanently marked unless the refuge biologist feels it is necessary. Navigating with a GPS ensures enough accuracy (e.g., within 2-4 m) for surveying points in consecutive years.

End-of-season procedures
Reviewing datasheets
During the field season or shortly after the field season has ended, biologists should review datasheets for accuracy and completeness. Datasheets should also be scanned and uploaded to a computer during or immediately after the field season to mitigate the impact of lost datasheets. Biologists should check for legibility of scans, accuracy of four-letter codes, and investigate any missing or incomplete information on datasheets. Correcting mistakes immediately following the field season helps maintain the integrity of the data and saves a significant amount of time during the data proofing process. If corrections are made to the datasheet, the datasheet should be rescanned to ensure scanned data are up-to-date.

Element 4: Data Management and Analysis
Data will be entered into and stored in the IMBCR relational database maintained by Bird Conservancy. Ideally, each person who collected data should enter their own data to minimize data entry errors due to handwriting misinterpretations.

Overview of database design
Data will be stored in a Structured Query Language (SQL) Server database to manage the landbird community and associated environmental data. This database has been developed by Bird Conservancy and will be used to house data collected for wildlife refuges participating in this protocol. This database uses a web-based front-end program for data entry and editing.

The general data model for bird-community monitoring consists of core tables and two principal groups of data tables. One group of tables manages bird detection data, and the other manages associated environmental data. Detection and environmental data are linked in time and space using standardized location and event tables that are shared with other protocols through the Bird Conservancy. When correctly linked, the bird-detection and environmental data may be transparently integrated for analysis.

The primary table for storing bird-detection data contains observation information such as species, distance from observer, how detected, sex, and flock size. Supporting tables include count dates, count start and end times, and sampling conditions (temperature, wind, sky). Tables associated with the environmental data contain information on point-level conditions (e.g., presence of cheatgrass or prairie dogs), percent overstory and midstory by species, and ground cover and understory height.

Bird Conservancy is in the process of developing and transitioning to a new PostgreSQL-backed data entry platform that will house the data for wildlife refuges participating in this protocol. The new database will use a web-based front-end program for protocol management, access control, data entry, and data editing.

Data entry and verification
Data should be entered by the individual conducting each survey or another designated individual. Data can be entered on a laptop computer without internet access, using an application developed by Bird Conservancy. After data are entered on the laptop computer, they can be uploaded to Bird Conservancy's database using the internet. Data should be entered as soon after a survey is completed as is practical. After data entry is completed, refuge staff should verify the data. Bird Conservancy staff can also enter and verify a refuge's data if there is a pre-arranged agreement. A refuge biologist should discuss an arrangement with the primary contact ahead of the field season.

Data entry
Although the primary goal of data entry is to transcribe all data from paper records into the database with 100% accuracy, this target is rarely achieved. To facilitate data-entry accuracy and to eliminate as many potential data-entry errors as possible, the data entry application has built-in many quality assurance/quality control (QA/QC) mechanisms. Bird Conservancy developed a data entry protocol that accompanies the data entry application (SOP 3). The refuge biologist

should ensure that all data-entry personnel have read this user guide and understand how to use the data entry application and follow the protocols.

Data entry is done via a web-based front end, with Firefox as the required browser. Data can be entered off-line and then uploaded to the database at a later time. Location and sampling event information are entered first. Then, associated bird and environmental data are entered into the targeted tables. Where appropriate, "pick lists" limit values entered into a field to ensure that only valid names or measures are entered. Bird or environmental values are selected directly from a "pick list" or by typing the first few characters of the value. The form searches for a similar entry, typically locating the desired value after typing only a few characters.

Data verification process

Data verification involves two steps: full proofing and query proofing. The first is the process of checking the accuracy of the digital data against copies of the original paper datasheets (i.e., full proofing), and it should immediately follow data entry. To minimize transcription errors in the final dataset, personnel familiar with the project's field and data collection methods should verify 100% of the records to the source documents. In 2012, Bird Conservancy developed a protocol for full proofing all field data collected (SOP 4). After initial corrections have been made in the database, refuge staff will perform the second step, query proofing (SOP 5), to catch errors that were not caught during the full proof process. These are usually errors made while collecting the data, and this step involves running queries to look for commonly made errors in three sections of the database:

1. Transect (grid) information (e.g., start and end times and sampling conditions),
2. Point data (e.g., point start times and reasons for not completing points), and
3. Bird data (e.g., distances, cluster IDs, how- detected codes, invalid minutes, incorrect minute counts, and invalid no-bird records).
4. Vegetation Data (e.g., covers summing to 100%, snags documented in the overstory, unknown codes)

Metadata

Metadata are developed and maintained by Bird Conservancy and stored within the database. Because this protocol is an adaptation of the IMBCR protocol using existing data fields, the metadata already exist. These metadata are not easily accessible to outside partners, but can be made available upon request. Bird Conservancy's new database, which will be complete and ready for use by 2020, will improve the integration of metadata with data fields, and make them more accessible to partners.

Data security and archiving

After data have been entered in Bird Conservancy's database, proofed, and the necessary corrections have been made in red pen on the data sheet hard copies, datasheets should be rescanned, saved and archived as electronic documents. Final electronic copies should be sent to the Bird Conservancy primary contact. Each refuge should maintain a copy of its datasheets on site or they may be archived in ServCat. Data stored on site should be filed with a copy of the site-specific survey protocol developed from this protocol framework. If archived in ServCat, any copies of data and or reports can be electronically cross-referenced to the survey protocol. The Bird Conservancy database will be archived on a secure server with regularly scheduled

back-ups. All changes made during proofing to hard data copies will be done with red ink and corrected datasheets will need to be re-scanned and stored on the server. For corrections made in the database and on hard data copies, a change log needs to be recorded to a spreadsheet (SOP 5), sent to the Bird Conservancy primary contact, and stored on a secure server.

Raw data can be queried through Bird Conservancy's Rocky Mountain Avian Data Center (http://rmbo.org/v3/avian/ExploretheData.aspx) via the raw data access or through ServCat. Contact the primary contact with Bird Conservancy for a username and password to access and download the raw data through Bird Conservancy's database. Analyzed data (e.g., density and occupancy estimates) will also be available on the Rocky Mountain Avian Data Center (see Element 5 for more details). Raw data from the IMBCR program are available to researchers for a variety of purposes, such as modeling bird–habitat associations that may be useful for identifying bird communities or environmental features of conservation or management concern (e.g., Niemuth et al. 2017). Non-IMBCR partners must complete a data sharing agreement and raw data are only available if the request is approved by IMBCR funding partners. Bird Conservancy will not share refuge data without approval from the respective refuge staff. Participating refuge staff do not need a data sharing agreement to access data collected on their refuge or to store their data in Bird Conservancy's database. Refuge staff ultimately control data collected on their respective refuge; these data will not be used or shared without refuge staff approval.

Analysis methods

Data analysis will likely be conducted by Bird Conservancy personnel experienced in distance sampling and occupancy modeling to obtain density, occupancy rates, and trend estimates. See *SOP 6: Data Analyses* for Bird Conservancy's current data analysis approach for the different estimators used. All estimators are calculated for each species within each stratum or individual refuge, and then "rolled-up" to produce regional estimates across participating refuges. By following the IMBCR sampling design and field protocol, participating refuges benefit from pooled detections across the IMBCR program for less-frequently detected species and the ability to compare refuge-specific estimates to the surrounding region (Pavlacky et al. 2017). Bird Conservancy staff could also help train refuge staff to conduct analyses for population estimates or additional analyses, such as bird-habitat relationships and diversity indices. For refuge staff with quantitative skills, the raw data will be available on ServCat and Bird Conservancy's internal database for in-house analysis and appropriate R script will also be shared with refuge staff.

Occupancy allows us to monitor changes in the proportion of sampling units occupied by a species over time (i.e., presence or absence) and accounts for imperfect detectability during estimation (MacKenzie et al. 2002). As such, occupancy serves as an indicator of changes in distribution and allows for explicit estimates of local extinction and colonization rates. Density is the number of individuals per sampling unit and we use Distance sampling theory to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. For strata or refuges with ≥ 2 years of data, we also provide trend estimates to describe the direction of population change and how certain we are of that change.

Other Analyses
Because participating refuges have access to the raw data they collect, any number of additional analyses, such as habitat modeling, could be conducted by refuge personnel with appropriate statistical skills. Additional analyses could also be conducted by contracting Bird Conservancy personnel trained in biostatistics.

Software
All analyses are completed using free software available online, mainly program R (R Core Team 2018) and JAGS (Plummer 2003).

Element 5: Reporting
Implications and application
Reporting will be annual and intended for multiple audiences. Important audiences include participating refuge personnel, state and federal wildlife agencies, avian non-profit organizations, universities, and other IMBCR partners. The primary delivery system will be the Internet via the IMBCR listserv and on Bird Conservancy of the Rockies' website (https://birdconservancy.org/resource-center/reports/).

Annual reports will summarize the results of the sampling effort for the year for major strata or areas of interest within the IMBCR program including participating refuges. Results will include number of surveys completed and number of species detected with a link to the Rocky Mountain Avian Data Center for population estimates and a map of survey locations. From the Rocky Mountain Avian Data Center's Explore the Data page, select "Individual Stratum" from the filter drop box and click add. Then select the refuge of interest from the list (strata are organized by state and Bird Conservation Region) and click add filter. Click the red "Run Query" button above the map view to view results. Approximate survey locations will be shown on a Google map platform, as well as density and occupancy estimates by species, counts by species, and sampling effort. For more information on using the Rocky Mountain Avian Data Center, contact Jen Timmer (jennifer.timmer@birdconservancy.org) or view videos and tutorials available on the site (hover over the 'Explore the Data" tab to see list of instructional materials).

In an effort to disseminate findings in a timely manner, annual reports will be completed by approximately March 1 following the year of data collection. Once data are entered and verified (SOPs 3-5), we anticipate that preparation of the annual report will take approximately two months. Bird Conservancy compiles results and completes one annual report for IMBCR partners rather than creating multiple individual reports. This is partly to streamline reporting efforts, but also to highlight a key strength of the IMBCR program, which is integrated monitoring. Monitoring within a nested framework across land types provides the ability to compare estimates within a stratum (e.g., individual refuge) to the surrounding region for context. See a copy of the 2017 IMBCR Annual Report (https://birdconservancy.org/wp-content/uploads/2018/05/2017-Final-IMBCR-Report.pdf; Woiderski et al. 2018) for what to expect in an annual report.

Element 6: Personnel Requirements and Training
Reliable results require data collected with adherence to field protocol, which requires informed and responsible data collectors. The refuge may utilize current staff, hire seasonal technicians, or contract Bird Conservancy or other IMBCR implementation partners (e.g., Intermountain Bird

Observatory) to conduct breeding landbird surveys. Recruitment should take place well before the field season to allow time for training and required paperwork to be approved.

Roles and responsibilities
The number of sites to be surveyed will determine the number of personnel or seasonal technicians required to collect the data (typically, one technician can complete 30 grids in a season). The survey coordinator, usually a Refuge Biologist, will be responsible for ensuring that survey protocol is followed. When the number of personnel helping to implement the survey becomes large (e.g., ≥ 4), it will be helpful to assign someone from the crew to assist the survey coordinator, particularly in organizing data collectors, making sure they have the necessary gear and forms, and relaying feedback.

Each survey coordinator will work with a primary contact from Bird Conservancy to implement this protocol. Due to the specialization of the work, it will be important for the survey coordinator (and assistant survey coordinator if needed) to be well-versed in all aspects of the protocol. The survey coordinator will be responsible for hiring seasonal technicians as needed, completing the field work, and entering, and verifying (or proofing) the data. Bird Conservancy will be responsible for training observers, managing and analyzing the data, and producing an annual report. Field technicians (if needed) will report directly to the refuge survey coordinator and the survey coordinator will report to the Bird Conservancy primary contact. Specific protocols followed for breeding landbird data collection are located in *SOP 2: Conducting Surveys*. Data entry will be conducted by refuge personnel during and shortly after the field season as necessary (*SOP 3: Data Entry*) and data verification and proofing will also be conducted by refuge personnel shortly after the field season (*SOP 4: Data Verification (Query Proof) and 5: Data Verification (Full Proof)*). A refuge has the option to contract Bird Conservancy (or other IMBCR implementation partner) to collect, enter, and/or verify the data. This agreement should be discussed with the primary contact at Bird Conservancy several months prior to the field season.

Qualifications
Field observers must be able to identify all birds on a refuge by sight and sound. Observers should also be physically fit and comfortable hiking and surveying in areas with potentially hazardous wildlife, terrain, and weather conditions. Observers should have prior experience conducting point count surveys, hiking long distances in steep and/or rugged terrain, and navigating with maps and GPS units. Excellent hearing and attention to detail are also requirements.

Training
Having qualified, competent, observers to ensure rigor and consistency in data collection is one of the most essential components for the long-term success of breeding landbird monitoring. This point cannot be overemphasized. Numerous studies have shown that bias among observers can confound estimates of population trends of songbird populations (Kendall et al. 1996, Link and Sauer 1998). In addition to being able to identify birds visually, field observers must be proficient at identifying birds aurally because many species are detected by sound only (Ramsey and Scott 1981). Further, the ability to precisely estimate distance to birds that are rarely seen is an essential skill (Buckland et al. 2004).

It is recommended that all observers spend several mornings conducting practice surveys in the field, familiarizing themselves with the protocol, equipment and datasheets that will be used in official surveys and verifying their ability to identify bird species. This will allow observers to focus on correctly recording all birds detected during official surveys. In addition, Bird Conservancy biologists will host a rigorous week-long training course prior to the field season to familiarize observers with the protocol (both data collection and data entry) and practice bird identification for common and rare species in a region. It is highly recommended that refuge personnel who will be conducting bird surveys contact their Bird Conservancy primary contact and sign up to attend the training course. During the training, participants will receive instruction and practice with the following:

● Distance and occupancy sampling methods,

● Review of point count protocol and habitat assessment (*SOP 2: Conducting Surveys*),

● Using a rangefinder, GPS unit, SPOT unit, and timer (*SOP 2: Conducting Surveys*),

● Bird identification by sight and sound,

● Practice (in the field) conducting point counts and identifying birds, and

● Entering bird data in the database (*SOP 3: Data Entry*).

Element 7: Operational Requirements

Budget
Each participating refuge that implements the IMBCR monitoring protocol will need to contract with Bird Conservancy as an IMBCR implementation partner. This means the refuge implements the fieldwork and provides the bird data to Bird Conservancy for analysis and reporting. This partnership promotes financial and administrative efficiencies for both parties as data across the IMBCR program can be pooled for less-common species and population estimates are placed in regional context (Pavlacky et al. 2017). Under this agreement, each refuge pays Bird Conservancy to set up the survey transects (i.e., 1-km^2 grids) in GIS across the refuge, stratify the refuge by ecological site or other feature if needed, manage and analyze the data, make the results and population estimates accessible via an online database, and produce an annual report. See Table 1 for estimated costs depending on the complexity of the monitoring set-up (i.e., stratification) and field training attendance. There are a variety of funding models that Bird Conservancy could implement for a refuge depending on resources and monitoring objectives for each refuge. Contact the Bird Conservancy primary contact to discuss other funding scenarios.

Table 1. Estimated costs for participating in the Integrated Monitoring in Bird Conservation Regions (IMBCR) program with Bird Conservancy of the Rockies. Costs shown are for an example project with 10 transects per refuge.

ITEM	COST PER REFUGE	INCLUDES
Transect Set-Up:		
Simple design (1 time fee)	$1,500-$2,000	Consultation and coordination regarding transect set-up in GIS, sample selection, and input into the database
More complicated design (1 time fee)	$2,000-$2,500	Consultation and coordination regarding transect set-up in GIS, refuge stratification, sample selection, and input into the database
Data Management & Partner Coordination:		
Same for all designs (annual fee)	$900-$1,100	Data storage and security, database updates, data analysis, and reporting
Field Training Course:		
Attend all or part of week-long course	$100-$700 ($100/day)	Training with IMBCR biologists on field protocol and GPS navigation, practice bird and plant ID, bird ID quizzes, campsite fees

Schedule

Major tasks throughout the year related to landbird sampling include pre-season planning, training and field preparation, field data collection, completion of data entry, and data verification and proofing (Table 2). Depending on the region where the participating refuge is located, observer training will begin in April or May, and surveys will begin right after training. In most years, surveys will end by July 1, but this is largely dependent on the elevation of the refuge. Within a region (and refuge), we begin surveying transects at the lowest elevations. Refuges with higher elevations or those located in more northern areas are surveyed as the season progresses (see Table SOP 2.1 for general survey windows based on state and elevation).

Table 2. Timeline of major tasks throughout the year for implementation partners (such as refuge personnel) of the Integrated Monitoring in Bird Conservation Regions (IMBCR) program and Bird Conservancy of the Rockies (BCR) personnel.

Approximate Deadlines	Program Area	BCR Personnel	Implementation Partners
Early January	Data delivery	Post population results online (http://rmbo.org/v3/avian/Home.aspx)	
Late January/early February	Partner coordination	Annual IMBCR partners meeting held at which improvements to the program, future directions and management questions are discussed	Attend IMBCR partners meeting if possible
Early March	Reporting	Annual IMBCR report sent to partners & posted online	

Late March	Field season prep work	Seasonal techs hired and sampling plan developed including the number of surveys to be conducted for each IMBCR stratum	Seasonal tech(s) hired and sampling plan developed including the number of surveys to be conducted for each refuge
Mid-April	Field work prep	Surveys, maps, and data sheets assembled for techs; access to grids on private property requested and granted; gear ordered and assigned	Surveys, maps, and data sheets assembled for tech(s); gear ordered and assigned
Late April to early July	Field work	Training completed to ensure techs understand IMBCR field methods and bird ID, field work completed	Training completed to ensure tech(s) understand IMBCR field methods and bird ID, field work completed
Late September	Data entry	Data entry completed	Data entry completed
Late October	Data reporting prep	Data proofing completed and compiled from all IMBCR partners	Full & query proofing of data completed; data sent to BCR
Late November	Preliminary prep work for field season	Previous year's sampling design reviewed and updated for next season as needed	Contact BCR to create or review sampling design for upcoming field season
Late December	Field work prep	Post job announcements for seasonal technicians	Post job announcement for seasonal technicians

Element 8: References

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Appendices

Appendix A: Datasheets for Landbird Monitoring

IMBCR Point-Transect Form

Observer (Login ID)	Date (YYYY/MM/DD)	Refuge	BCR	Transect ID	Time
					Sky
					Wind
					Temp

Overstory - all spp. total to 100%

Point info		Other (Y/N)																				
Point	Private property?	GPS Accuracy	Point	Midstory Present	Cliff/rock?	P-dog town?	P-dogs present?	Cheatgrass?	Point	Primary Habitat	% Overstory	Overstory Mean Height	# Snags	Species #1	Sp 1 % cover	Species #2	Sp 2 % cover	Species #3	Sp 3 % cover	Species #4	Sp 4 % cover	Species #5	Sp 5 % cover
1			1						1														
2			2						2														
3			3						3														
4			4						4														
5			5						5														
6			6						6														
7			7						7														
8			8						8														
9			9						9														
10			10						10														
11			11						11														
12			12						12														
13			13						13														
14			14						14														
15			15						15														
16			16						16														

Understory layer - all spp. total to 100%

Point	% Shrub Cover	Shrub Mean height (m)	Species #1	Sp 1 % cover	Species #2	Sp 2 % cover	Species #3	Sp 3 % cover	Species #4	Sp 4 % cover	Species #5	Sp 5 % cover
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												

If found, please mail to:
Bird Conservancy of the Rockies
230 Cherry St, Fort Collins, CO
Or call: (970) 482 - 1707

Ground Cover - totals to 100%

Points	% Snow	% Water	% Woody	% Dead and Down	% Herbaceous	% Dead Standing Grass	% Live Grass	% Litter	% Bare	Dead Standing Grass Height (cm)	Live Grass & Herb. Height (cm)
1											
2											
3											
4											
5											
6											
7											
8											

Ground Cover - totals to 100%

Points	% Snow	% Water	% Woody	% Dead and Down	% Herbaceous	% Dead Standing Grass	% Live Grass	% Litter	% Bare	Dead Standing Grass Height (cm)	Live Grass & Herb. Height (cm)
9											
10											
11											
12											
13											
14											
15											
16											

Figure A. 1. Example breeding landbird habitat datasheet.

Point	Reasons points were not conducted. If O, provide an explanation below.
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Observer ID			Year			Transect ID	
			2 0				

Order of Importance	Please record the reasons why you did not survey certain points within the grid (if applicable). If more than one of the codes below apply, please record ONLY the code of highest importance.	
Most	P:	Private Property - Denied Permission
	N:	Private Property - No contact with landowner
	U:	Terrain Unsafe (could not safely approach to within 25 m of point)
	R:	Can't cross River
	S:	Snow pack impassible
	H:	Running water near point - unable to Hear
	W:	Weather (rain or wind)
	G:	No GPS reception, cannot find point
	T:	Ran out of Time (five hours past sunrise or noticeably decreased bird activity)
Least	O:	Other - explain

Figure A. 2. Example breeding landbird back of habitat datasheet.

USFWS Landbird Survey Data

Page _____ of _____

Observer	Date (YYYY/MM/DD)	Refuge	BCR	Transect Name

How: V=visual; S=singing; C=calling; F=flyover; D=drumming; O=other aural detection

Between points: point # = 88 | Sex: M=male, F=female; U=unknown; J=juvenile

Start Time	Point #	Minute	Species	Radial Distance (meters)	How Detected	Sex	Visual?	Migrating?	Cluster Size	Cluster Code	Start Time	Point #	Minute	Species	Radial Distance (meters)	How Detected	Sex	Visual?	Migrating?	Cluster Size	Cluster Code

Notes:

Figure A. 3. Example breeding landbird survey datasheet.

Appendix B: Primary Habitat Codes and Key of Two-Letter Codes for Shrubs and Trees

Table B. 1. Two-letter code to describe primary habitat at breeding landbird survey point.

Two-Letter Code	Habitat Description
AR	Vegetation has been planted by humans for food production or ornamental purposes in sparsely developed areas. Examples include a farmed field with wheat, corn, millet, etc., a fallow field, a rural home site with planted non-native species, or a park planted with non-native species. Please make note of crop spp., if fallow, etc.
AS	Overstory dominated by aspen although scattered ponderosa pine or Douglas-fir may be present. The overstory cover should be ≥10% and consist of ≥50% aspen. Aspen stands often have an abundant and diverse shrub layer. Typical shrub species in aspen habitats include snowberry, willow, sagebrush, mountain mahogany, and oak. On occasion there may be no shrub layer. Typically the ground under aspen stands is covered by grasses and forbs.
AT	High-elevation, open landscapes that occur above tree line. These areas should have ≤5% overstory and often lack a significant shrub component. Ground cover consists of short grasses (generally ≤10 cm in height), wild flowers, mosses, lichens, and succulents.
BA	Area with little vegetation or rock present. These areas are typically characterized by large amounts of gravel, sand, silt, clay, or other earthen material and tend to be eroded. May include sand dunes, buttes, badlands formations, gravel pits, and desert pavement. The sum of live and dead grass must account for <10% of ground cover and shrub cover should be <10%. Exposed rock and boulders must make up <20% of ground cover (see Cliff/Rock). Barren habitat should not experience significant seasonal flooding (see Playa).
BU	Forest habitat where ≥50% of canopy is dead and shows evidence of severe fire scars or where ≥50% of trees have burned and fallen.
CR	Area is dominated by rock and/or generally lacking vegetative cover (e.g., talus slopes, boulder fields, and rocky outcroppings). Areas described as Cliff/Rock should have ≤10% shrub cover and <10% canopy cover. Bare rock should make up ≥20% of the exposed ground cover.
DS	Dry landscape containing shrubs, but lacking a co-dominant grass component. % shrub cover should be ≥10. Shrubs often include sagebrush, greasewood, Fremont mahonia and saltbush. Sagebrush must comprise ≤30% of the shrub composition (see Sage Shrubland). Ground cover layer is typically dominated by bare ground and rock with limited forbs and grasses present. Grass and forbs make up ≤20% of ground cover (see Shrubland).

DW	Habitat consisting of ≥10% canopy cover that is dominated by deciduous species other than Aspen or Oak species. Native deciduous species should comprise ≥50% of the canopy cover and Aspen or Oak spp. must comprise ≤50% of the canopy cover. The 50m radius should not include a permanent or seasonal water source (see Riparian).
GR	Landscape lacking an overstory and significant shrub component. Ground cover is dominated by grasses and perhaps some forbs. Shrub component must be <10% (see Shrubland). The sum of live and dead standing grass must be ≥10%.
HW	Land that was historically considered to be a wetland, but has since dried up. Wetland vegetation still dominates the landscape, although it is probably dried up and dead.
II	Forested habitat with ≥10% of the overstory composition dead or sickly - typically referring to pine and spruce bark beetles affecting several species of pine and spruce trees. Canopy cover must be ≥10%.
JF	Areas with ≥5% overstory cover that is made up primarily of Jeffrey pine. This habitat often includes other tree types such as fir and Ponderosa pine, but Jeffrey pine should comprise ≥50% of the overstory layer. Shrub cover can vary from sparsely to heavily vegetated. Ground cover typically dominated by grass species.
LA	Overstory dominated by larch although other coniferous and deciduous species may be present. The overstory cover should be ≥10% and consist of ≥50% larch.
LO	Area within a forested habitat that has been recently logged. Overstory cover should be ≤10% (see a variety of forest primary habitats). Shrub cover should be ≤10% (see Shrubland). There should be little to no regrowth of shrub and/or overstory species. Ground cover typically consists primarily of grasses, stumps and dead and down timber.
LP	Habitat consisting of ≥10% canopy cover that is dominated by lodgepole pine. Canopy may have other conifer species or some aspen, but lodgepole pine must comprise ≥50% of the overstory cover. Shrub layer can be conspicuous or nearly absent.
MB	Forested habitat surrounding riparian corridors that consists of ≥50% mesquite species. Canopy cover should be ≥10%. Ground cover typically consists primarily of grasses.
MC	Forested habitat consisting of several species of conifers, such as ponderosa pine, lodgepole pine, Douglas-fir, or spruce/fir spp. If the area is dominated by Douglas-fir, use Mixed Conifer as the primary habitat type. Canopy cover should be ≥10%. Overstory may range from very dense to relatively open. Undergrowth is complex and typically contains deciduous shrubs and/or conifer saplings. Stands with dense overstory may have little or no shrub and ground cover.
MM	Areas with little to no overstory that are surrounded by forests. Elevations should be ≥2,133 m. Soils should be moist to wet with forbs or grass as the dominant ground cover. Canopy cover should be ≤10%. Shrub layer should be ≤10%.
OA	Habitat dominated by oaks (*Quercus* spp.), often accompanied by juniper, ponderosa pine, pinyon pine, or Chihuahuan Pine. The overstory and shrub cover must sum to ≥10% cover, with oak species making up ≥50% of that cover. In some instances there may be little or no overstory because the Oak species that are present are <3 m high. In southern Arizona this habitat code should be used for Madrean woodlands.

OW	Habitat consisting of ≥50% open water, bank, and shoreline. Any other habitat type may be present, but must be <50%.
PJ	Vegetative communities largely influenced by pinyon pine, juniper, or a combination of the two species. The overstory and shrub cover must sum to ≥10%. Semi-arid conditions often produce a relatively short overstory. Juniper tends to dominate at lower elevations while pinyon dominates at higher elevations. Typically, shrub layer includes sagebrush, rabbit brush, oak, or mahogany. Ground cover is usually dominated by grasses with fewer forbs. In some instances there may be little or no overstory because the PJ that is present is <3 m high.
PL	Shallow, ephemeral wetland that experiences significant seasonal changes in semi-arid to arid climates, including the Great Plains. They are primarily filled by rainfall, although playas found in agricultural settings may also receive water from irrigation runoff. They often have high salinity or may be completely dry. Some wetland-loving plants like sedges or rushes may be present even when surface water is not present.
PP	Areas with ≥5% overstory cover that is made up primarily of ponderosa pine. This habitat often includes other tree types such as fir, pine, and aspen, but ponderosa pine should comprise ≥50% of the overstory layer. Shrub layer relatively open and often includes common juniper, oak, cliffrose, and currants. Ground cover typically dominated by grass species. This code should be used even if there is a significant oak understory.
RI	Stands or strips of trees or shrubs near a permanent or seasonal water source. Typical tree and shrub species include cottonwood, box elder, maple, aspen, alder, and willows. Riparian areas are typically discrete habitats, often surrounded by coniferous forest, grassland, shrubland or sagebrush habitat. If riparian habitat is present within the 50-m radius, this should be the primary habitat type.
SA	Habitat where grasses and shrubs are co-dominant and the shrub cover is ≥10%. Shrub species must consist of ≥30% sagebrush. Typical ground cover is dominated by grasses with limited forbs and bare ground.
SF	Coniferous forest that is dominated by spruce and fir species (typically occurring at elevations ≥2,133 m). Note that Douglas-fir is not a true fir species (see Mixed Conifer). Overstory cover should be ≥10% with spruce and fir species comprising ≥50% of the overstory cover. Variable understory typically includes shrubs and forbs with few grasses.
SH	Landscape co-dominated by grass and shrub species. Shrub cover must be ≥10%. Sagebrush must be <30% of shrub layer (see Sage Shrubland). Typical shrub species include ceonothus, manzanita, sage, rabbitbrush, currant, skunkbrush, serviceberry, and plum. Grass and forbs should make up ≥20% of ground cover (see Desert/Semi desert Shrubland).
UR	Areas highly impacted by human development in which ≥20% of the ground is covered by impermeable surfaces. Typically describing relatively dense development including houses, lawns, sidewalks, parking areas, and streets.

WE	Habitat influenced by permanent or seasonal flooding resulting in tall reeds, grasses, and/or cattails with little to no overstory. This habitat is defined by the presence of some emergent vegetation that is adapted to wet soils or inundation. Typical species include cattails, sedges, rushes, and sphagnum mosses. Overstories are limited to drier areas around the wetland and overstory cover should be ≤10%.
WP	Mid to high elevation habitat (>1,829 m) dominated by whitebark pine. The overstory cover should be >5% and consist of >50% whitebark pine.
WR	Habitat consisting of ≥10% canopy cover that is dominated by western cedar species including western redcedar, incense cedar, and Alaska cedar. Canopy may have other conifer or deciduous species, but cedar species must comprise ≥50% of the overstory cover.
XX	Primary habitat type does not fall into any of the above categories. This code is generally used when working in a new study area that has habitat types not encountered previously on IMBCR surveys. Make sure you write notes in the margin on the right of the datasheet explaining what you think the primary habitat should be described as for this point.

Table B. 2. Two-letter code to describe overstory and shrub plant species at each landbird survey point.

Code	Common Name	Scientific Name	States
AA	Acacia	*Acacia sp.*	AZ, CA, KS, NM, NV, OK, TX, UT
AG	Agave	*Agave sp.*	AZ, CA, NM, NV, TX, UT
AL	Alder	*Alnus sp.*	AZ, CA, CO, ID, KS, MT, NM, ND, NV, OK, TX, UT, WA, WY
AE	American Elm	*Ulmus americana*	CO, KS, MT, ND, NE, OK, SD, TX, WY
HH	American Hophornbeam	*Ostrya virginiana*	KS, ND, NE, OK, SD, TX, WY
LI	American Linden / Basswood	*Tilia americana*	KS, ND, NE, OK, SD
AP	American Plum	*Prunus americana*	All
AM	Apache Plume	*Fallugia paradoxa*	AZ, CA, CO, NM, NV, OK, TX, UT
AW	Arizona Black Walnut	*Juglans major*	AZ, NM, OK, TX, UT
AC	Arizona Cypress	*Cupressus arizonica*	AZ, CA, NM, NV, TX, UT
AH	Ash	*Fraxinus sp.*	All
AK	Ashy Silktassel	*Garrya flavescens*	AZ, CA, NM, NV, UT
BA	Baccharis / Mule Fat	*Baccharis sp.*	AZ, CA, CO, KS, NM, NV, OK, OR, TX, UT
BP	Balsam Poplar	*Populus balsamifera*	CA, CO, ID, MT, ND, NV, OR, SD, UT, WA, WY
BT	Barrel Cactus	*Ferocactus sp.*	AZ, CA, NM, NV, TX, UT
BE	Beaked Hazelnut	*Corylus cornuta*	CA, CO, ID, MT, ND, OR, SD, WA, WY
BG	Beargrass	*Nolina sp.*	AZ, CA, CO, NM, NV, OK, TX, UT
BM	Bigtooth Maple / Little Canyon Maple	*Acer grandidentatum*	AZ, CO, ID, MT, NM, NV, TX, UT, WA, WY
BI	Birch	*Betula sp.*	All
BY	Bitter Cherry	*Prunus emarginata*	AZ, CA, ID, MT, NM, NV, OR, UT, WA, WY
PT	Black Cottonwood	*Populus trichocarpa*	CA, ID, MT, ND, NV, OR, WA, WY, UT
BN	Black Walnut	*Juglans nigra*	CO, KS, ND, NE, NM, OK, SD, TX, UT
BB	Blackberry / Raspberry / Thimbleberry	*Rubus sp.*	All
BL	Blackbrush	*Coleogyne ramosissima*	AZ, CA, CO, NV, UT
BK	Bladder Sage	*Salazaria mexicana*	AZ, CA, NV, TX, UT
BS	Blue Spruce	*Picea pungens*	AZ, CO, ID, NM, UT, WY
BX	Box Elder	*Acer negundo*	All
BR	Bristlecone Pine	*Pinus aristata*	AZ, CO, NM
EN	Brittlebush	*Encelia sp.*	AZ, CA, NV, UT
AB	Buckthorn	*Rhamnus sp.*	All
BF	Buffaloberry	*Shepherdia canadensis*	AZ, CA, CO, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY
BO	Bur Oak	*Quercus macrocarpa*	CO, KS, MT, ND, NE, NM, OK, SD, TX, WY
BC	burnt conifer		All
BD	burnt deciduous		All
BW	Burroweed	*Isocoma tenuisecta*	AZ, NM, TX
LU	Bush Lupine	*Lupinus sp.*	All

BH	Buttonbush	*Cephalanthus occidentalis*	AZ, CA, KS, NE, OK, TX
CL	Catalpa	*Catalpa sp.*	CA, KS, NE, OK, OR, SD, TX
CM	Catclaw mimosa	*Mimosa aculeaticarpa*	AZ, NM, TX
CA	Ceanothus	*Ceanothus sp.*	All
CB	Chaffbush	*Amphipappus sp.*	AZ, CA, NV, UT
CK	Chickasaw Plum	*Prunus angustifolia*	CA, CO, KS, NE, NM, OK, TX
CP	Chihuahuan Pine	*Pinus leiophylla*	AZ, NM
CC	Choke Cherry	*Prunus virginiana*	All
CH	Cholla / Pencil Cactus	*Cylindropuntia sp.*	AZ, CA, CO, KS, NM, NV, OK, TX, UT
CR	Cliffrose / Bitterbrush	*Purshia sp.*	AZ, CA, CO, ID, MT, NE, NM, NV, OR, TX, UT, WA, WY
CJ	Common Juniper	*Juniperus communis*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, UT, WA, WY
CO	Condalia	*Condalia sp.*	AZ, CA, NM, TX
CW	Crack Willow	*Salix fragilis*	CO, ID, KS, MT, ND, NE, NM, OR, SD, UT, WY
CE	Creosote	*Larrea tridentata*	AZ, CA, NM, NV, TX, UT
CT	Crucifiction Thorn	*Canotia holacantha*	AZ
DL	Dalea / Prairie Clover / Featherplume	*Dalea sp.*	All
DA	dead Aspen		All
DC	dead conifer		All
DD	dead deciduous		All
DJ	dead Juniper		All
DY	dead Pinyon Pine		All
DM	Desert Almond	*Prunus fasciculata*	AZ, CA, NV, UT
DH	Desert Honeysuckle	*Anisacanthus thurberi*	AZ, NM
LV	Desert Lavender	*Hyptis emoryi*	AZ, CA, NV
DO	Desert Olive	*Forestiera neomexicana*	AZ, CA, CO, NM, NV, OK, TX, UT
DP	Desert Polygala	*Polygala acanthoclada*	AZ, CA, UT
DR	Desert Rue	*Thamnosma montana*	AZ, CA, NV, UT
DE	Desert Willow / Desert Catalpa	*Chilopsis linearis*	AZ, CA, KS, NM, NV, OK, TX, UT
DW	Dogwood	*Cornus sp.*	All
DF	Douglas Fir	*Pseudotsuga menziesii*	AZ, CA, CO, ID, MT, NM, NV, OR, TX, UT, WA, WY
EB	Elderberry	*Sambucus sp.*	All
EM	Elm	*Ulmus sp.*	All
ES	Engelmann Spruce	*Picea engelmannii*	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WY
FD	Fairy Duster	*Calliandra eriophylla*	AZ, CA, NM, TX
FB	Fendlerbush	*Fendlera rupicola*	AZ, CO, NM, NV, TX, UT
FE	Fernbush	*Chamaebatiaria millefolium*	AZ, CA, CO, ID, NM, NV, OR, TX, UT
FH	Fool's Huckleberry	*Menziesia ferruginea*	CA, ID, MT, OR, WA, WY
FC	Fremont Cottonwood	*Populus fremontii*	AZ, CA, CO, NM, NV, TX, UT
FM	Fremont Mahonia / Barberry / Desert Holly	*Berberis sp.*	AZ, CA, CO, ID, KS, MT, ND, NE, NM, NV, OR, SD, TX, UT, WA, WY

FR	Fremont's Buckwheat / Crispleaf Buckwheat	*Eriogonum corymbosum*	AZ, CO, NM, NV, UT, WY
GO	Gambel Oak	*Quercus gambelii*	AZ, CO, NM, NV, OK, SD, TX, UT, WY
TT	Glandulare Labrador Tea / Trappers Tea	*Ledum Glandulosum*	CA, ID, MT, NV, OR, UT, WA, WY
GL	Globemallow	*Sphaeralcea angustifolia*	AZ, CA, CO, KS, NE, NM, NV, OK, TX
GB	Gooseberry / Currant	*Ribes sp.*	All
GF	Grand Fir	*Abies grandis*	CA, ID, MT, OR, WA
GW	Greasewood	*Sarcobatus sp.*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, TX, UT, WA, WY
GA	Green Ash	*Fraxinus pennsylvanica*	CO, KS, MT, ND, NE, NM, OK, SD, TX, UT, WY
GM	Greenmolly	*Bassia americana*	AZ, CA, CO, ID, MT, NM, NV, OR, TX, UT, WY
GY	Gum Bully / Woolly Buckthorn	*Sideroxylon lanuginosum*	AZ, KS, NM, OK, TX
HK	Hackberry	*Celtis sp.*	All
HA	Hawthorn	*Crataegus sp.*	All
EC	Hedgehog Cactus	*Echinocereus sp.*	AZ, CA, CO, KS, NE, NM, NV, OK, SD, TX, UT, WY
HC	Hickory	*Carya sp.*	KS, ND, NE, OK, TX
HL	Honey Locust	*Gleditsia triacanthos*	All
HT	Hoptree	*Ptelea sp.*	AZ, CO, KS, NE, NM, TX, UT
HO	Horsebrush	*Tetradymia sp.*	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY
HB	Huckleberry	*Vaccinium sp.*	AZ, CO, ID, KS, MT, ND, NM, OR, SD, TX, UT, WA, WY
XX	Identified But Not Listed		All
IC	Incense Cedar	*Calocedrus decurrens*	CA, NV, OR
IB	Indigo bush / Leadplant	*Amorpha sp.*	All
IO	Iodinebush	*Allenrolfea occidentalis*	AZ, CA, ID, NM, NV, OR, TX,UT
JP	Jeffrey Pine	*Pinus jeffreyi*	CA, NV, OR
JO	Jojoba	*Simmondsia chinensis*	AZ, CA, UT
JT	Joshua Tree	*Yucca brevifolia*	AZ, CA, NV, UT
JU	Juniper	*Juniperus sp.*	All
KC	Kentucky Coffee Tree	*Gymnocladus dioicus*	KS, ND, NE, OK, SD, TX
KO	Kochia / Molly /Burningbush / Smotherweed	*Bassia sp.*	All
LM	Limber Pine	*Pinus flexilis*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, UT, WY
LW	Little Walnut	*Juglans microcarpa*	KS, NM, OK, TX
LL	Loblolly Pine	*Pinus taeda*	OK, TX
LT	Locust sp.	*Robinia sp.*	All
LP	Lodgepole Pine	*Pinus contorta*	CA, CO, ID, MT, NV, OR, SD, UT, WA, WY
LB	Lote Bush	*Ziziphus obtusifolia*	AZ, CA, NM, NV, OK, TX, UT
MD	Madrone	*Arbutus arizonica*	AZ, NM
MZ	Manzanita	*Arctostaphylos sp.*	AZ, CO, MT, NM, TX, UT, WY
ML	Maple	*Acer sp.*	All
MR	Mariola	*Parthenium incanum*	AZ, NM, NV, TX, UT
ME	Mesquite	*Prosopis sp.*	AZ, CA, CO, KS, NM, NV, OK, TX, UT

MK	Mock Orange	*Philadelphus sp.*	AZ, CA, CO, ID, MT, NM, NV, OK, OR, TX, UT, WA, WY
MB	Mojave sea-blite	*Suaeda nigra*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, TX, UT, WA, WY
MT	Mormon Tea	*Ephedra sp.*	AZ, CA, CO, NM, NV, OK, OR, TX, UT, WY
MO	Mountain Ash	*Sorbus scopulina*	AZ, CA, CO, MT, ND, NM, NV, OR, SD, UT, WA, WY
MH	Mountain Hemlock	*Tsuga mertensiana*	CA, ID, MT, NV, OR, WA
MM	Mountain Mahogany	*Cercocarpus sp.*	AZ, CA, CO, ID, KS, MT, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY
MS	Mountain Spray / Oceanspray	*Holodiscus sp.*	AZ, CA, CO, ID, MT, NM, NV, OR, TX, UT, WA, WY
MU	Mulberry	*Morus sp.*	All
NC	Narrow-leaf Cottonwood	*Populus angustifolia*	AZ, CA, CO, ID, MT, NE, NM, NV, SD, TX, UT, WA, WY
LC	New Mexico Locust	*Robinia neomexicana*	AZ, CA, CO, NM, NV, TX, UT, WY
NB	Ninebark	*Physocarpus sp.*	All
OB	Oak	*Quercus sp.*	All
OL	Ocotillo	*Fouquieria splendens*	AZ, CA, NM, NV, TX
OR	Oreganillo	*Aloysia wrightii*	AZ, CA, NM, NV, TX, UT
OX	Oregon Boxwood	*Paxistima myrsinites*	All
OG	Oregon-grape	*Mahonia aquifolium*	AZ, CA, CO, ID, MT, ND, NE, NM, OR, SD, TX, UT, WA, WY
OE	Osage Orange	*Maclura pomifera*	CA, CO, KS, NE, NM, OK, OR, SD, TX, UT, WA
YE	Pacific Yew	*Taxus brevifolia*	CA, ID, MT, NV, OR, WA
PV	Palo Verde	*Cercidium floridum*	AZ, CA, NV
PB	Paper Birch	*Betula papyrifera*	CO, ID, MT, ND, NE, OR, SD, WA, WY
PW	Peachleaf Willow	*Salix amigdaloides*	All
PM	Persimmon	*Diospyros sp.*	CA, KS, NE, OK, TX, UT
PY	Pinyon Pine	*Pinus edulis*	AZ, CA, CO, NM, NV, OK, TX, UT, WY
PC	Plains Cottonwood	*Populus deltoides*	AZ, CO, KS, MT, ND, NE, NM, OK, SD, TX, UT, WY
PI	Poison Ivy	*Toxicodendron radicans*	AZ, KS, NE, OK, SD, TX
PP	Ponderosa Pine	*Pinus ponderosa*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY
PO	Poplar	*Populus sp.*	All
PA	Prickly Ash	*Zanthoxylum americanum*	KS, ND, NE, OK, SD, TX
OP	Prickly Pear	*Opuntia sp.*	All
AS	Quaking Aspen	*Populus tremuloides*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, TX, UT, WA, WY
RA	Rabbitbrush	*Chrysothamnus sp.*	AZ, CA, CO, ID, KS, MT, NE, NM, NV, OK, OR, TX, UT, WA, WY
BU	Ragweed / Bursage	*Ambrosia sp.*	All
RR	Range Ratany	*Krameria parvifolia*	AZ, CA, NM, NV, TX, UT
RS	Ratany	*Krameria sp.*	AZ, CO, KS, NM, OK, TX, UT
RG	Rayless Goldenhead	*Acamptopappus*	AZ, CA, NV, UT

		sphaerocephalus	
RB	Redbud	*Cercis sp.*	AZ, CA, KS, NM, NE, NV, OK, TX, UT
RD	Red-osier Dogwood	*Cornus sericea*	AZ, CA, CO, ID, KS, MT, ND, NE, NM, NV, OR, SD, UT, WA, WY
RH	Rhododendron	*Rhododendron sp.*	CA, CO, ID, MT, OK, OR, TX, WA
MA	Rocky Mountain Maple	*Acer glabrum*	All
RO	Russian Olive	*Elaegnus angustifolia*	All
SA	Sagebrush	*Artemisia sp.*	All
CG	Saguaro	*Carnegiea gigantea*	AZ, CA
SL	Saltbush	*Atriplex sp.*	All
SD	Sand Cherry	*Prunus pumila*	CO, KS, MT, ND, NE, OR, SD, UT, WY
SB	Serviceberry	*Amelanchier sp.*	All
SR	Shinnnery Oak / Havard Oak	*Quercus havardii*	AZ, CO, KS, NM, OK, TX, UT
LO	Shrub Live Oak	*Quercus turbinella*	AZ, CA, CO, NM, NV, TX, UT
SC	Shrubby Cinquefoil	*Pentaphylloides floribunda*	AZ, CA, CO, ID, MT, ND, NM, OR, SD, UT, WA, WY
EL	Siberian Elm	*Ulmus pumila*	All
SI	Siberian Peashrub / Caragana	*Caragana arborescens*	CA, CO, ID, MT, ND, NE, NM, OR, SD, UT, WA, WY
SM	Silver Maple	*Acer saccharinum*	CA, KS, ND, NE, NM, OK, SD, TX, WA
SE	Single-leaf Ash	*Fraxinus anomala*	AZ, CA, CO, NM, NV, UT, WY
SK	Skunkbrush	*Rhus trilobata*	All
SS	Smooth Sumac	*Rhus glabra*	All
SN	Snag		All
SW	Snakeweed	*Gutierrezia sarothrae*	All
SY	Snowberry	*Symphoricarpos sp.*	All
YS	Soaptree Yucca	*Yucca elata*	AZ, NM, NV, TX, UT
PS	Southwestern White Pine	*Pinus strobiformis*	AZ, CO, NM, TX
ST	Spindletree / Wahoo	*Euonymus sp.*	CO, KS, MT, ND, NE, OK, SD, TX
SH	Spiny Hopsage	*Grayia spinosa*	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA WY
SP	Spiraea	*Spiraea betulifolia*	ID, MT, ND, OR, SD, WA, WY
SU	Subapline Fir	*Abies lasiocarpa*	AZ, CA, CO, ID, MT, NM, NV, UT, WA, WY
SZ	Sugar Sumac	*Rhus ovata*	AZ, CA
US	Sumac	*Rhus sp.*	All
PL	Sycamore	*Platanus sp.*	AZ, CA, KS, NE, NM, OK, TX, WA
TA	Tamarisk / Saltcedar	*Tamarix pentandra*	All
TR	Tarbush	*Flourensia cernua*	AZ, NM, TX
TH	Tree of Heaven	*Ailanthus altissima*	AZ, CA, CO, ID, KS, NE, NM, NV, OK, OR, TX, UT, WA
TW	Twinberry / Bush Honeysuckle	*Lonicera sp.*	All
UC	Unknown coniferous species		All
UD	Unknown deciduous species		All
OT	Unknown Plant		All

VI	Viburnum	*Viburnum sp.*	CA, CO, ID, KS, MT, ND, NE, NM, OK, OR, SD, TX, WA, WY
WB	Water Birch	*Betula occidentalis*	AZ, CA, CO, ID, MT, ND, NE, NM, NV, OR, SD, UT, WA, WY
WX	Waxflower	*Jamesia americana*	AZ, CA, CO, NM, NV, UT, WY
HE	Western Hemlock	*Tsuga heterophylla*	CA, ID, MT, OR, WA
LA	Western Larch	*Larix occidentalis*	ID, MT, OR, UT, WA, WY
WC	Western Red Cedar	*Thuja plicata*	CA, ID, MT, OR, WA
WW	Western White Pine	*Pinus monticola*	CA, ID, MT, NV, OR, UT, WA
WF	White Fir	*Abies concolor*	AZ, CO, ID, NM, NV, OR, UT, WY
WS	White Spruce	*Picea glauca*	ID, MT, SD, WY
WP	Whitebark Pine	*Pinus albicaulis*	CA, ID, MT, NV, OR, WA, WY
PF	White-stem Paper-flower	*Psilostrophe cooperi*	AZ, CA, NM, NV, UT
WT	Whitetop / Pepperweed / Cress Shrub	*Cardaria / Lepidium sp.*	All
WG	Wild Grape	*Vitis sp.*	All
WR	Wild Rose	*Rosa sp.*	All
WI	Willow	*Salix sp.*	All
WY	Wingleaf Soapberry	*Sapindus saponaria*	AZ, CO, NM, KS, OK, TX
WN	Winterfat	*Krascheninnikovia lanata*	All
WO	Wolfberry	*Lycium pallidum*	AZ, CA, CO, NM, NV, OK, TX, UT
WR	Wright's Buckwheat	*Eriogonum wrightii*	AZ, CA, NM, NV, TX, UT
YU	Yucca	*Yucca sp.*	AZ, CA, CO, KS, MT, ND, NE, NM, NV, OK, SD, TX, UT, WY

Appendix C: Four-letter Codes for Bird Species

Table C. 1. Four-letter codes for birds detected during breeding landbird surveys.

Common Name[1]	Code[2]	Common Name[1]	Code[2]	Common Name[1]	Code[2]
Abert's Towhee	ABTO	Barn Swallow	BARS	Black-throated Blue Warbler	BTBW
Acadian Flycatcher	ACFL	Barred Owl	BDOW	Black-throated Gray Warbler	BTYW
Acorn Woodpecker	ACWO	Barrow's Goldeneye	BAGO	Black-throated Green Warbler	BTNW
Alder Flycatcher	ALFL	Bell's Vireo	BEVI	Black-throated Sparrow	BTSP
American Avocet	AMAV	Belted Kingfisher	BEKI	Blue Grosbeak	BLGR
American Bittern	AMBI	Bendire's Thrasher	BETH	Blue Jay	BLJA
American Coot	AMCO	Bewick's Wren	BEWR	Blue-gray Gnatcatcher	BGGN
American Crow	AMCR	Black Phoebe	BLPH	Blue-throated Hummingbird	BLUH
American Dipper	AMDI	Black Rail	BLRA	Blue-winged Teal	BWTE
American Goldfinch	AMGO	Black Rosy-Finch	BLRF	Blue-winged Warbler	BWWA
American Kestrel	AMKE	Black Swift	BLSW	Boat-tailed Grackle	BTGR
American Pipit	AMPI	Black Tern	BLTE	Bobolink	BOBO
American Redstart	AMRE	Black Vulture	BLVU	Bohemian Waxwing	BOWA
American Robin	AMRO	Black-and-white Warbler	BAWW	Bonaparte's Gull	BOGU
American Three-toed Woodpecker	ATTW	Black-backed Woodpecker	BBWO	Boreal Chickadee	BOCH
American Tree Sparrow	ATSP	Black-bellied Whistling-Duck	BBWD	Boreal Owl	BOOW
American White Pelican	AWPE	Black-billed Cuckoo	BBCU	Botteri's Sparrow	BOSP
American Wigeon	AMWI	Black-billed Magpie	BBMA	Brewer's Blackbird	BRBL
Anna's Hummingbird	ANHU	Black-capped Chickadee	BCCH	Brewer's Sparrow	BRSP
Arizona Woodpecker	AZWO	Black-capped Gnatcatcher	BCGN	Bridled Titmouse	BRTI
Ash-throated Flycatcher	ATFL	Black-chinned Hummingbird	BCHU	Broad-billed Hummingbird	BBLH
Baird's Sandpiper	BASA	Black-chinned Sparrow	BCSP	Broad-tailed Hummingbird	BTLH
Baird's Sparrow	BAIS	Black-crested Titmouse	BCTI	Broad-winged Hawk	BWHA
Bald Eagle	BAEA	Black-crowned Night-Heron	BCNH	Bronzed Cowbird	BROC
Baltimore Oriole	BAOR	Black-headed Grosbeak	BHGR	Brown Creeper	BRCR
Band-tailed Pigeon	BTPI	Black-necked Stilt	BNST	Brown Pelican	BRPE
Bank Swallow	BANS	Blackpoll Warbler	BLPW	Brown Thrasher	BRTH
Barn Owl	BNOW	Black-tailed Gnatcatcher	BTGN	Brown-capped Rosy-Finch	BCRF

Common Name[1]	Code[2]	Common Name[1]	Code[2]	Common Name[1]	Code[2]
Brown-crested Flycatcher	BCFL	Chihuahuan Raven	CHRA	Curve-billed Thrasher	CBTH
Brown-headed Cowbird	BHCO	Chimney Swift	CHSW	Dark-eyed Junco	DEJU
Buff-breasted Flycatcher	BBFL	Chipping Sparrow	CHSP	Dark-eyed Junco (Gray-headed)	GHJU
Buff-collared Nightjar	BCNI	Chuck-will's-widow	CWWI	Dark-eyed Junco (Oregon)	ORJU
Bufflehead	BUFF	Chukar	CHUK	Dark-eyed Junco (Pink-sided)	PSJU
Bullock's Oriole	BUOR	Cinnamon Teal	CITE	Dark-eyed Junco (Red-backed)	RBJU
Burrowing Owl	BUOW	Clapper Rail	CLRA	Dark-eyed Junco (Slate-colored)	SCJU
Bushtit	BUSH	Clark's Grebe	CLGR	Dark-eyed Junco (White-winged)	WWJU
Cackling Goose	CACG	Clark's Nutcracker	CLNU	Dickcissel	DICK
Cactus Wren	CACW	Clay-colored Sparrow	CCSP	Double-crested Cormorant	DCCO
California Gull	CAGU	Cliff Swallow	CLSW	Downy Woodpecker	DOWO
California Quail	CAQU	Common Black-Hawk	CBHA	Dusky Flycatcher	DUFL
Calliope Hummingbird	CAHU	Common Gallinule	COGA	Dusky Grouse	DUGR
Canada Goose	CANG	Common Goldeneye	COGO	Dusky-capped Flycatcher	DCFL
Canvasback	CANV	Common Grackle	COGR	Eared Grebe	EAGR
Canyon Towhee	CANT	Common Ground-Dove	COGD	Eastern Bluebird	EABL
Canyon Wren	CANW	Common Loon	COLO	Eastern Kingbird	EAKI
Carolina Chickadee	CACH	Common Merganser	COME	Eastern Meadowlark	EAME
Carolina Wren	CARW	Common Nighthawk	CONI	Eastern Phoebe	EAPH
Caspian Tern	CATE	Common Peafowl	CPEA	Eastern Screech-Owl	EASO
Cassin's Finch	CAFI	Common Poorwill	COPO	Eastern Wood-Pewee	EAWP
Cassin's Kingbird	CAKI	Common Raven	CORA	Elegant Trogon	ELTR
Cassin's Sparrow	CASP	Common Tern	COTE	Elf Owl	ELOW
Cassin's Vireo	CAVI	Common Yellowthroat	COYE	Eurasian Collared-Dove	EUCD
Cattle Egret	CAEG	Cook's Petrel	COPE	European Starling	EUST
Cave Swallow	CASW	Cooper's Hawk	COHA	Evening Grosbeak	EVGR
Cedar Waxwing	CEDW	Cordilleran Flycatcher	COFL	Ferruginous Hawk	FEHA
Chestnut-backed Chickadee	CBCH	Costa's Hummingbird	COHU	Ferruginous Pygmy-Owl	FEPO
Chestnut-collared Longspur	CCLO	Crested Caracara	CRCA	Field Sparrow	FISP
Chestnut-sided Warbler	CSWA	Crissal Thrasher	CRTH	Flammulated Owl	FLOW

Common Name[1]	Code[2]	Common Name[1]	Code[2]	Common Name[1]	Code[2]
Forster's Tern	FOTE	Greater Roadrunner	GRRO	House Wren	HOWR
Fox Sparrow	FOSP	Greater Sage-Grouse	GRSG	Hutton's Vireo	HUVI
Franklin's Gull	FRGU	Greater Scaup	GRSC	Inca Dove	INDO
Gadwall	GADW	Greater White-fronted Goose	GWFG	Indigo Bunting	INBU
Gambel's Quail	GAQU	Greater Yellowlegs	GRYE	Indigo x Lazuli Bunting Hybrid	ILBH
Gila Woodpecker	GIWO	Great-tailed Grackle	GTGR	Juniper Titmouse	JUTI
Gilded Flicker	GIFL	Green Heron	GRHE	Killdeer	KILL
Golden Eagle	GOEA	Green Kingfisher	GKIN	King Rail	KIRA
Golden-crowned Kinglet	GCKI	Green-tailed Towhee	GTTO	Ladder-backed Woodpecker	LBWO
Golden-crowned Sparrow	GCSP	Green-winged Teal	AGWT	Lark Bunting	LARB
Golden-fronted Woodpecker	GFWO	Groove-billed Ani	GBAN	Lark Sparrow	LASP
Golden-winged Warbler	GWWA	Gunnison Sage-Grouse	GUSG	Lawrence's Goldfinch	LAGO
Grace's Warbler	GRWA	Hairy Woodpecker	HAWO	Lazuli Bunting	LAZB
Grasshopper Sparrow	GRSP	Hammond's Flycatcher	HAFL	Le Conte's Sparrow	LCSP
Gray Catbird	GRCA	Harlequin Duck	HARD	Le Conte's Thrasher	LCTH
Gray Flycatcher	GRFL	Harris's Hawk	HRSH	Least Bittern	LEBI
Gray Hawk	GRHA	Harris's Sparrow	HASP	Least Flycatcher	LEFL
Gray Jay	GRAJ	Heermann's Gull	HEEG	Least Grebe	LEGR
Gray Partridge	GRPA	Henslow's Sparrow	HESP	Least Sandpiper	LESA
Gray Vireo	GRVI	Hepatic Tanager	HETA	Least Tern	LETE
Gray-cheeked Thrush	GCTH	Hermit Thrush	HETH	Lesser Goldfinch	LEGO
Gray-crowned Rosy-Finch	GCRF	Hermit Warbler	HEWA	Lesser Nighthawk	LENI
Great Blue Heron	GBHE	Herring Gull	HERG	Lesser Prairie-Chicken	LEPC
Great Crested Flycatcher	GCFL	Hooded Merganser	HOME	Lesser Scaup	LESC
Great Egret	GREG	Hooded Oriole	HOOR	Lesser Yellowlegs	LEYE
Great Gray Owl	GGOW	Hooded Warbler	HOWA	Lewis's Woodpecker	LEWO
Great Horned Owl	GHOW	Horned Grebe	HOGR	Lincoln's Sparrow	LISP
Greater Pewee	GRPE	Horned Lark	HOLA	Little Blue Heron	LBHE
Greater Prairie-Chicken	GRPC	House Finch	HOFI	Loggerhead Shrike	LOSH
		House Sparrow	HOSP	Long-billed Curlew	LBCU

Common Name[1]	Code[2]	Common Name[1]	Code[2]	Common Name[1]	Code[2]
Long-billed Dowitcher	LBDO	Northern Flicker (Yellow-shafted)	YSFL	Plumbeous Vireo	PLVI
Long-eared Owl	LEOW	Northern Goshawk	NOGO	Prairie Falcon	PRFA
Louisiana Waterthrush	LOWA	Northern Harrier	NOHA	Prothonotary Warbler	PROW
Lucifer Hummingbird	LUHU	Northern Hawk Owl	NOHO	Purple Finch	PUFI
Lucy's Warbler	LUWA	Northern Mockingbird	NOMO	Purple Martin	PUMA
MacGillivray's Warbler	MGWA	Northern Parula	NOPA	Pygmy Nuthatch	PYNU
Magnificent Hummingbird	MAHU	Northern Pintail	NOPI	Pyrrhuloxia	PYRR
Magnolia Warbler	MAWA	Northern Pygmy-Owl	NOPO	Red Crossbill	RECR
Mallard	MALL	Northern Rough-winged Swallow	NRWS	Red Phalarope	REPH
Marbled Godwit	MAGO	Northern Saw-whet Owl	NSWO	Red Squirrel	RESQ
Marsh Wren	MAWR	Northern Shoveler	NSHO	Red-bellied Woodpecker	RBWO
McCown's Longspur	MCLO	Northern Waterthrush	NOWA	Red-breasted Merganser	RBME
Merlin	MERL	Olive Warbler	OLWA	Red-breasted Nuthatch	RBNU
Mexican Chickadee	MECH	Olive-sided Flycatcher	OSFL	Red-breasted Sapsucker	RBSA
Mexican Jay	MEJA	Orange-crowned Warbler	OCWA	Red-eyed Vireo	REVI
Mississippi Kite	MIKI	Orchard Oriole	OROR	Red-faced Warbler	RFWA
Montezuma Quail	MONQ	Osprey	OSPR	Redhead	REDH
Mountain Bluebird	MOBL	Ovenbird	OVEN	Red-headed Woodpecker	RHWO
Mountain Chickadee	MOCH	Pacific-slope Flycatcher	PSFL	Red-naped Sapsucker	RNSA
Mountain Plover	MOUP	Painted Bunting	PABU	Red-necked Grebe	RNGR
Mourning Dove	MODO	Painted Redstart	PARE	Red-necked Phalarope	RNPH
Mourning Warbler	MOWA	Pectoral Sandpiper	PESA	Red-shouldered Hawk	RSHA
Nashville Warbler	NAWA	Peregrine Falcon	PEFA	Red-tailed Hawk	RTHA
Nelson's Sparrow	NESP	Phainopepla	PHAI	Red-winged Blackbird	RWBL
Northern Beardless-Tyrannulet	NBTY	Pied-billed Grebe	PBGR	Ring-billed Gull	RBGU
Northern Bobwhite	NOBO	Pileated Woodpecker	PIWO	Ring-necked Duck	RNDU
Northern Cardinal	NOCA	Pine Grosbeak	PIGR	Ring-necked Pheasant	RINP
Northern Flicker	NOFL	Pine Siskin	PISI	Rock Pigeon	ROPI
Northern Flicker (Intergrade)	FLIN	Pinyon Jay	PIJA	Rock Wren	ROWR
Northern Flicker (Red-shafted)	RSFL	Piping Plover	PIPL	Roseate Spoonbill	ROSP

Common Name[1]	Code[2]	Common Name[1]	Code[2]	Common Name[1]	Code[2]
Rose-breasted Grosbeak	RBGR	Song Sparrow	SOSP	Veery	VEER
Rose-throated Becard	RTBE	Sooty Grouse	SOGR	Verdin	VERD
Rough-legged Hawk	RLHA	Sora	SORA	Vermilion Flycatcher	VEFL
Ruby-crowned Kinglet	RCKI	Spotted Owl	SPOW	Vesper Sparrow	VESP
Ruby-throated Hummingbird	RTHU	Spotted Sandpiper	SPSA	Violet-crowned Hummingbird	VCHU
Ruddy Duck	RUDU	Spotted Towhee	SPTO	Violet-green Swallow	VGSW
Ruffed Grouse	RUGR	Sprague's Pipit	SPPI	Virginia Rail	VIRA
Rufous Hummingbird	RUHU	Spruce Grouse	SPGR	Virginia's Warbler	VIWA
Rufous-crowned Sparrow	RCSP	Squirrel (Abert's)	ABSQ	Warbling Vireo	WAVI
Rufous-winged Sparrow	RWSP	Steller's Jay	STJA	Western Bluebird	WEBL
Rusty Blackbird	RUBL	Stilt Sandpiper	STSA	Western Flycatcher	WEFL
Sabine's Gull	SAGU	Sulphur-bellied Flycatcher	SBFL	Western Grebe	WEGR
Sage Sparrow	SAGS	Summer Tanager	SUTA	Western Kingbird	WEKI
Sage Thrasher	SATH	Swainson's Hawk	SWHA	Western Meadowlark	WEME
Sandhill Crane	SACR	Swainson's Thrush	SWTH	Western Sandpiper	WESA
Savannah Sparrow	SAVS	Swamp Sparrow	SWSP	Western Screech-Owl	WESO
Say's Phoebe	SAPH	Tennessee Warbler	TEWA	Western Tanager	WETA
Scaled Quail	SCQU	Thick-billed Kingbird	TBKI	Western Wood-Pewee	WEWP
Scarlet Tanager	SCTA	Townsend's Solitaire	TOSO	Whip-poor-will	WPWI
Scissor-tailed Flycatcher	STFL	Townsend's Warbler	TOWA	Whiskered Screech-Owl	WHSO
Scott's Oriole	SCOR	Tree Swallow	TRES	White-breasted Nuthatch	WBNU
Sedge Wren	SEWR	Tricolored Heron	TRHE	White-crowned Sparrow	WCSP
Semipalmated Plover	SEPL	Tropical Kingbird	TRKI	White-crowned Sparrow (Gambel's)	GWCS
Sharp-shinned Hawk	SSHA	Trumpeter Swan	TRUS	White-crowned Sparrow (Mountain)	MWCS
Sharp-tailed Grouse	STGR	Tufted Titmouse	TUTI	White-eared Hummingbird	WEHU
Short-eared Owl	SEOW	Turkey Vulture	TUVU	White-eyed Vireo	WEVI
Snow Goose	SNGO	Upland Sandpiper	UPSA	White-faced Ibis	WFIB
Snowy Egret	SNEG	Varied Bunting	VABU	White-tailed Kite	WTKI
Snowy Plover	SNPL	Varied Thrush	VATH	White-tailed Ptarmigan	WTPT
Solitary Sandpiper	SOSA	Vaux's Swift	VASW		

Common Name[1]	Code[2]
White-throated Sparrow	WTSP
White-throated Swift	WTSW
White-winged Crossbill	WWCR
White-winged Dove	WWDO
Whooping Crane	WHCR
Wild Turkey	WITU
Willet	WILL
Williamson's Sapsucker	WISA
Willow Flycatcher	WIFL
Wilson's Phalarope	WIPH
Wilson's Plover	WIPL
Wilson's Snipe	WISN
Wilson's Warbler	WIWA
Winter Wren	WIWR
Wood Duck	WODU
Woodhouse's Scrub-Jay	WOSJ
Wood Stork	WOST
Worm-eating Warbler	WEWA
Yellow Warbler	YWAR
Yellow-bellied Flycatcher	YBFL
Yellow-bellied Sapsucker	YBSA
Yellow-billed Cuckoo	YBCU
Yellow-billed Magpie	YBMA
Yellow-breasted Chat	YBCH
Yellow-eyed Junco	YEJU
Yellow-green Vireo	YGVI
Yellow-headed Blackbird	YHBL
Yellow-rumped Warbler	YRWA
Yellow-rumped Warbler (Audubon's)	AUWA

Common Name[1]	Code[2]
Yellow-rumped Warbler (Myrtle)	MYWA
Yellow-throated Vireo	YTVI
Yellow-throated Warbler	YTWA
Zone-tailed Hawk	ZTHA
Unknown Accipiter	UNAC
Unknown Bird	UNBI
Unknown Blackbird	UNBL
Unknown Buteo	UNBU
Unknown Cardinal	UNCA
Unknown Chickadee	UNCH
Unknown Cormorant	UNCT
Unknown Corvid	UNCO
Unknown Dove	UNDO
Unknown Duck	UNDU
Unknown Empidonax	UNEM
Unknown Falcon	UNFA
Unknown Finch	UNFI
Unknown Flicker	UNFR
Unknown Flycatcher	UNFL
Unknown Gnatcatcher	UNGN
Unknown Grouse	UNGR
Unknown Gull	UNGU
Unknown Hawk	UNHA
Unknown Hummingbird	UNHU
Unknown Jay	UNJA
Unknown Kingbird	UNKI
Unknown Meadowlark	UNME
Unknown Myiarchus	UNMY
Unknown Nuthatch	UNNU
Unknown Oriole	UNOR

Common Name[1]	Code[2]
Unknown Owl	UNOW
Unknown Pipit	UNPI
Unknown Raptor	UNRA
Unknown Sandpiper	UNSA
Unknown Sparrow	UNSP

[1]Common names of birds follow the American Ornithologist's Union (2007).
[2]Four-letter species codes follow the USGS Bird Banding Laboratory (https://www.usgs.gov/centers/pwrc/science/bird-banding-laboratory?qt-science_center_objects=0#qt-science_center_objects).

Standard Operating Procedures

Standard Operating Procedure 1: Sampling Design
Standard Operating Procedure 2: Conducting Surveys
Standard Operating Procedure 3: Data Entry
Standard Operating Procedure 4: Data Verification (Full Proof)
Standard Operating Procedure 5: Data Verification (Query Proof)
Standard Operating Procedure 6: Data Analyses

Standard Operating Procedure 1: Sampling Design

Define the target universe
The target universe is the population to which you want to make inferences. In the context of wildlife monitoring, the target universe includes both the organisms and the geographic area of interest. The target universe may be, for example, "all diurnal landbirds on _____ National Wildlife Refuge during the breeding season." As another example, for a refuge composed of a mix of ponds and uplands, inferences may be restricted to uplands, in which case the target universe may be "all diurnal landbirds in upland portions of _____ National Wildlife Refuge during the breeding season." For long-term monitoring it is important that the target universe remains fixed each year; otherwise, parameter estimates (e.g., density of a particular bird species) will not be comparable among years. If a refuge contains an area with restricted access that would prevent the area from being surveyed for landbirds, a decision may be made to exclude such an area from the target universe, but note that this will preclude one's ability to make inferences about landbird populations on the excluded area.

Establish the sampling frame
The geographical sampling frame is composed of all potential sampling units in the geographical target universe (Thompson 2002). In this landbird monitoring framework, sampling units consist of 1-km^2 grids or transects. This protocol will likely work best for refuges ≥10km^2 in size to ensure adequate sampling effort, but smaller refuges interested in conducting bird monitoring are encouraged to reach out to the primary contact with Bird Conservancy (jennifer.timmer@birdconservancy.org) to discuss it.

Stratification
It may be beneficial to stratify the target universe for one or more of the following reasons:

(1) Separate parameter estimates are desired for subsets of the target universe (for example, wilderness and non-wilderness areas);

<div align="center">or</div>

(2) Restoration treatments or other management activities are conducted on part of a refuge and the biologist would like to compare bird populations between treated and untreated areas.

Stratum boundaries should be based on fixed attributes such as administrative boundaries or geological features (e.g., soil types or elevation zones). Do not stratify on existing vegetation conditions or other factors that could quickly change over time because the location of each stratum should remain fixed from year to year. Note that the number of samples needed to obtain robust estimates of density or site occupancy is similar for an entire un-stratified refuge and for a single stratum. Therefore, a refuge divided into three strata will require more total sampling than a refuge that is not stratified. If stratification is used, every portion of the target universe must be assigned to one of the strata. If there is a part of the refuge to which a biologist doesn't wish to make inference to (e.g., body of water), it can be excluded from the sampling area.

A refuge biologist should contact their primary contact, Jennifer Timmer at Bird Conservancy (jennifer.timmer@birdconservancy.org), for consultation on setting up a refuge as a stratum (or to stratify a refuge) and to determine sampling effort for a refuge. Bird Conservancy GIS personnel will delineate the sampling frame by using GIS to superimpose a uniform grid of 1-km^2 cells over the refuge (or subset of a refuge as defined by the target universe; Figure SOP 1.1). After intersecting the grid with the refuge boundary in GIS, Bird Conservancy will assign each grid cell to one stratum based on refuge objectives (e.g., a grid cell can be assigned to a stratum if it is contained entirely within a boundary, if it is >50% contained in a boundary, if it is >75% contained in a boundary, and so on).

Finally, using GIS, Bird Conservancy will establish 16 evenly spaced sampling points within each grid cell; points will be 250 m apart and 125 m from cell boundaries (Figure SOP 1.2). Bird Conservancy staff can also work with refuge staff to provide guidance on sample design and sample unit selection if a refuge wishes to conduct these tasks for future monitoring efforts.

Select samples
Bird Conservancy GIS personnel will select samples using Generalized Random-Tessellation Stratification (GRTS), a spatially balanced sampling algorithm (Stevens and Olsen 2004). GRTS orders all of the sampling units in the sampling frame (e.g., a refuge) such that any set of consecutively numbered sampling units is a spatially balanced sample (Figure SOP 1.3). If the Refuge has been stratified, a GRTS sample will be drawn from each stratum.

The sampling effort will vary from refuge to refuge depending on size of the refuge, diversity in vegetation and other features on the refuge, monitoring objectives, and monitoring budgets. In general, Bird Conservancy recommends a minimum of 10 sampling units be surveyed per refuge or per stratum if a refuge is stratified. However, robust density and occupancy estimates may be possible with a smaller sampling effort and Bird Conservancy biometricians can advise accordingly.

Refuge biologists should survey transects in order using the transect's rank (denoted by the digits at the end of the transect number ordered from lowest to highest). However, the IMBCR sampling design allows for transects to be "skipped" if certain conditions are met, retaining a spatially balanced, random sample. If a transect cannot be completed, refuge biologists will need to pull a backup survey with the next lowest rank beyond the number in the original sample plan. For example, if you were planning on surveying transects 1-10 in a stratum and transect six was not accessible, you would select transect ranked 11 as the backup for that survey. For a transect to be considered "complete", a minimum of six points must be surveyed if the transect falls entirely on public land (four points if a portion of the grid falls on private land, which is not likely an issue for refuges).

Refuge biologists will need to look at both access to the transect and the transect itself to assess whether a survey can be completed. Refuge biologists should carefully review transects where access may be restricted due to unsafe terrain and make an educated decision on whether the minimum number of points can be safely surveyed. Past experience has shown that terrain typically becomes unsafe when there is more than 121 m of elevation gain or loss between point count stations. This represents an average slope of 45 degrees. In order to eliminate bias, every transect should be attempted, provided that access to the minimum number of points is

physically possible and does not jeopardize the safety of the person surveying. Every effort should be made to survey transects regardless of their distance from the nearest road as long as it does not put the surveyor at risk.
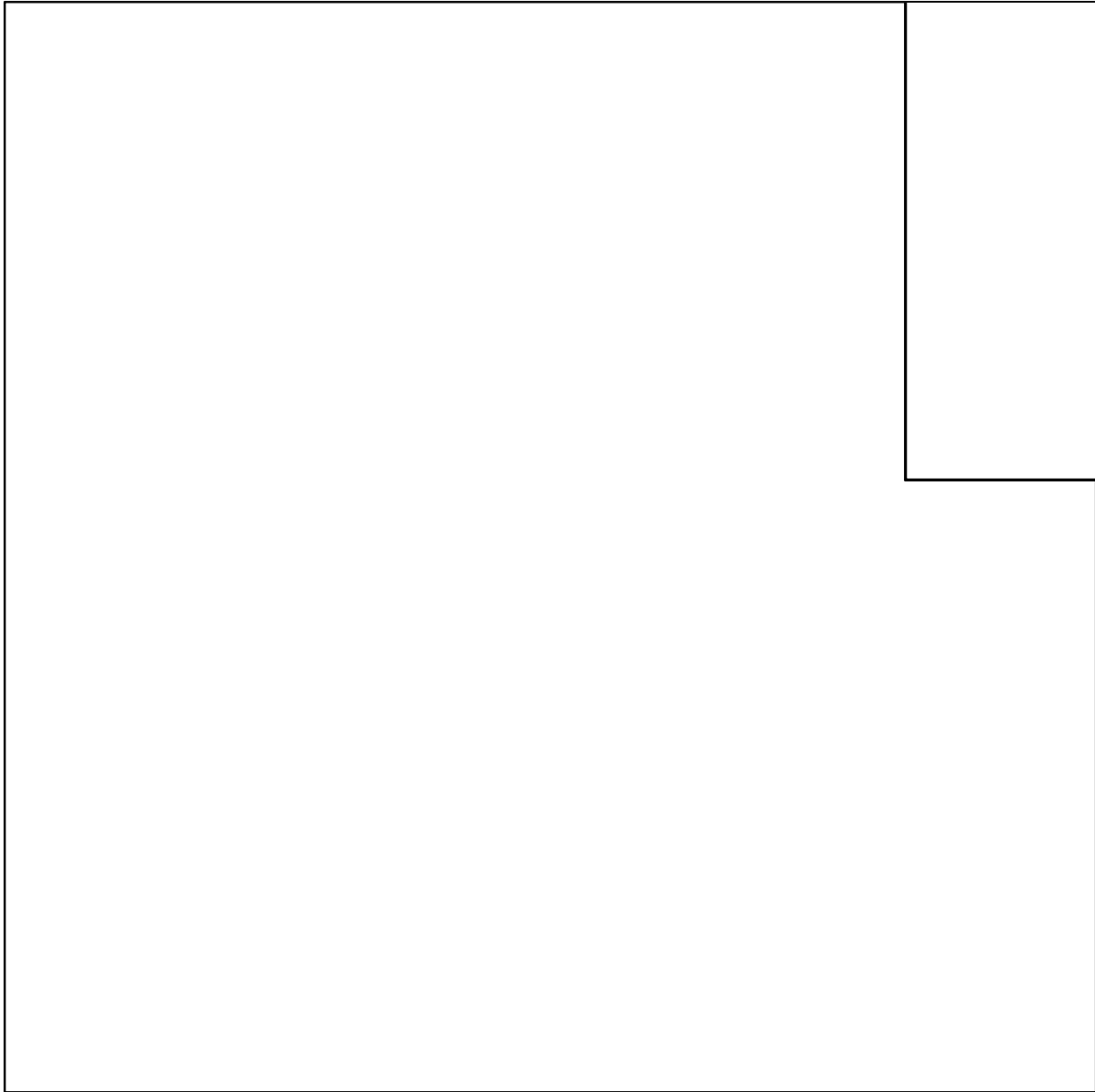

Figure SOP 1. 1. The 1 km^2 US National Grid superimposed on a hypothetical National Wildlife Refuge boundary.
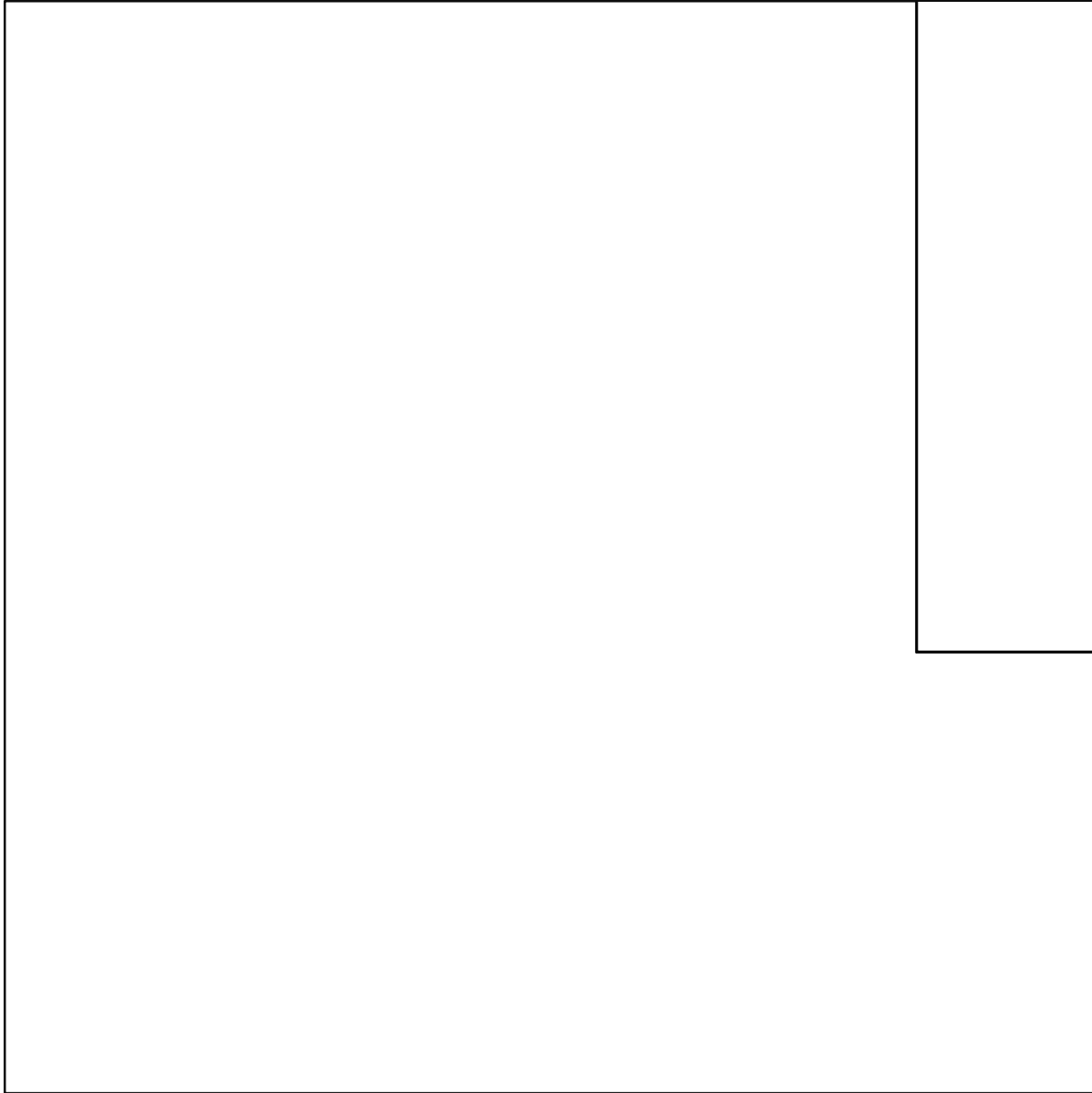
Figure SOP 1. 2. Evenly spaced sampling points within a 1 km² sampling unit. Note that sample points are spaced 250 m apart and are at least 125 m from the sampling unit boundary.
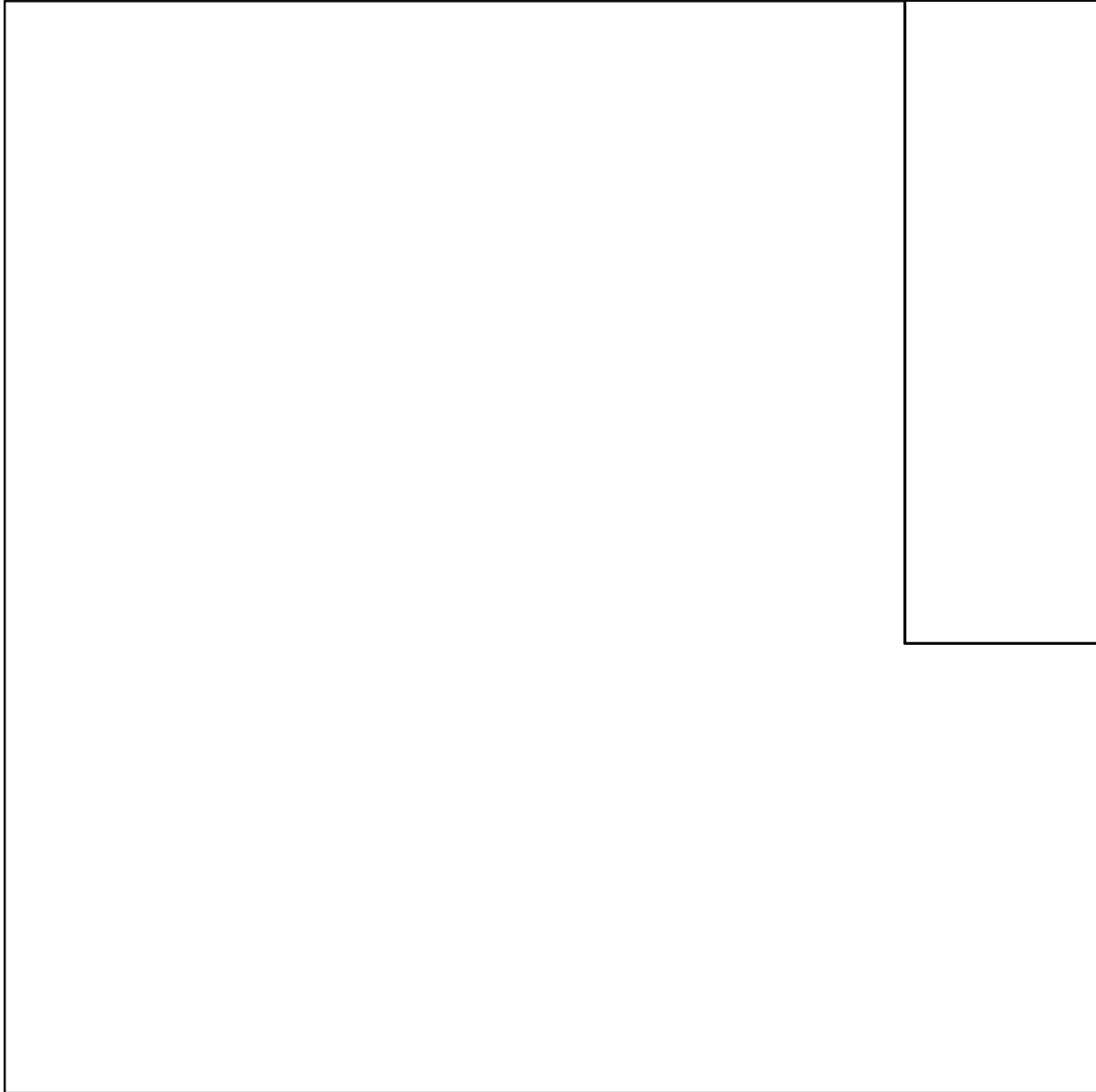
Figure SOP 1. 3. Sampling units selected by generalized random-tessellation stratification (GRTS) within a hypothetical National Wildlife Refuge. Note that GRTS produces ordered samples.

References

Stevens, D. L. Jr. and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262–278.

Thompson, W. L. 2002. Towards reliable bird surveys: accounting for individuals present but not detected. The Auk 119:18–25.

Standard Operating Procedure 2: Conducting Surveys

The protocol outlined in this SOP follows protocol developed for the Integrated Monitoring in Bird Conservation Regions program (Hanni et al. 2012).

Materials
Each observer will need to have the following equipment before training and before conducting landbird surveys:

1) Timepiece with a countdown timer and a chime;
2) Binoculars with good magnification and field of view ($\geq$ 7 x 35 magnification);
3) Clipboard (with instruction sheets attached);
4) Writing utensils (pencil or indelible ink pen);
5) GPS unit containing survey locations;
6) Laser rangefinder;
7) Extra batteries for GPS unit and rangefinder;
8) SPOT or other safety satellite tracking device;
9) Datasheets (Appendix A);
10) Maps of survey locations;
11) Plant ID guide
12) Master list of primary habitat codes and plant species codes (Appendix B);
13) Master list of bird species codes (Appendix C).

Conducting Surveys
When to collect data
Surveys should be conducted soon after migratory landbirds have returned to the refuge to be monitored. Surveys conducted too early in the year may record migrant birds that are moving through the area but not breeding on the refuge and/or may miss recording late-arriving migrant species. Breeding phenology for any given species varies by latitude, elevation and annual weather conditions. Therefore, exact timing of surveys may vary by a week or two from year-to-year and should be based on bird behavior and local knowledge of breeding phenology on a refuge rather than a strict calendar date. Below is a list of the optimal survey dates for each states in Southern and Mountain-Prairie Regions, as well as Idaho and Nevada. There is some flexibility in frequency of surveys if a refuge is interested in a panel design or conducting landbird surveys every other year. They should contact their primary contact at Bird Conservancy to discuss these options as needed.

Table SOP 2. 1. Recommended survey windows for breeding landbirds based on elevation within the Great Plains, Rocky Mountains, and Intermountain West region.

Arizona & New Mexico:	
<1,000 m	April 20 - May 10
1,000 m - 1,500 m	May 1 - May 20
1,501 m - 2,000 m	May 10 - June 10
2,001 m - 2,300 m	May 20 - June 20
>2,300 m	June 10 - July 5

Colorado, Utah, & Nevada:	
<1,981 m	May 10 - June 10
1,981 m - 2,438 m	June 1 - June 25
2,439 m - 2,834 m	June 10 - July 10
>2,835 m	July 1 - July 15
Idaho & Montana:	
<2,300 m	May 25 - June 15
2,300 m - 2,835 m	June 5 - June 30
>2,835 m	July 1 - July 15
Kansas:	
entire state	May 1 - June 15
Nebraska & South Dakota:	
<900 m	May 20 - June 15
900 m - 1,500 m	June 1 - June 26
>1,500 m	June 27 - July 10
North Dakota:	
entire state	June 1 - June 26
Oklahoma & Texas:	
entire state	April 20 - June 15
Wyoming:	
<2,000 m	May 20 - June 20
2,000 m - 2,300 m	June 5 - July 1
2,301 m - 2,600 m	June 15 - July 10
>2,600 m	July 1 - July 20

Biologists should survey each individual point during the time of day that songbirds are most detectable, generally between ½ hour before sunrise and five hours after sunrise. This may require the biologist to walk to the first survey location of the morning in the dark or camp out the night before near the survey location. In either case, the biologists should familiarize themselves in the daylight with the area to be surveyed.

How to collect data
Refer to Figures SOP 2.1 and 2.2 for an example of a landbird datasheet containing example data. Appendix A contains blank data sheets. Upon reaching a point, fill out the GPS accuracy and habitat data on the datasheet first (Figure SOP 2.1). **DO NOT begin counting until after this is done** (however, do identify and make a note on your datasheet of the locations of any birds flushed from around the count station upon your approach). Filling out the habitat data first is important for two reasons: 1) it will ensure that you do not forget to write it down, and 2) it will allow the local birds to "settle down" after the disturbance you created while approaching the point.

There may be instances where you should not or cannot conduct the survey from the exact point location. In these instances, observers may conduct a point count from anywhere within a 25 m

radius of the exact point count location. Common reasons why an observer might survey up to 25 m from a point count station include: 1) the point count station does not afford good visibility (a boulder, rock or other obstruction is blocking your view, or it is down in a wash), or 2) it is difficult to hear (often times running water can make hearing birds difficult but moving a few steps away greatly improves your aural detection ability). You should make every effort to conduct the count from the exact point location and only survey up to 25 m from a point if it is absolutely necessary. If you are unable to get within 25 m of the exact point location, most likely because of a physical barrier, then do not survey the point.

What to record

Fill in the habitat data for each point surveyed while at the point. Unlike the bird data, which we record to an unlimited distance from each point, **we only record habitat data within a 50-m radius of each point**. We use the habitat data to relate bird density to vegetation features and habitat types. This information will have real applications for managing habitats for birds, so please be as accurate as possible with these data. Because it is very important to finish as many point counts as possible in a morning, we ask that you do not spend more than a couple minutes filling in habitat data at each point. Collect samples of unknown plant species (place in a numbered zip lock bag) so you can identify them after completing the survey. Press collected plant samples as soon as possible to ensure accurate identification after bird surveys are completed. Below is a description of the fields found on the vegetation datasheet and brief instructions on recording these data. Please refer to Figure SOP 2.1 for an example of a completed vegetation datasheet.

Site Data

> **Observer:** Enter the unique login that was provided to you
>
> **Date:** Enter the date using the following format: YYYY/MM/DD
>
> **Transect ID:** Enter the full character code identifying the state, stratum and transect number (e.g., CO-BCR16-AR8) as it appears on the transect description page. It is important to fill out the FULL name of the transect.
>
> **Time:** (start and end) Enter start and stop times in military time for the entire transect using **Mountain Daylight Time**. Record the start time when you arrive at your first point and begin recording site data. Record the stop time once you've completed your final point count for the morning.
>
> **Sky:** (start and end) Enter one-digit codes at beginning and end of the point count grid survey (not for each point)

0=0-15% cloud cover 1=16-50% cloud cover   2=51-75% cloud cover
3=76-100% cloud cover   5=fog 6=drizzle
8=Light snow

You should not survey in any other conditions!

Wind: (start and end)**:** Enter one-digit codes at beginning and end of the point count grid:

0=Less than 1 mph; smoke rises vertically
1=1-3 mph; smoke drift shows wind direction
2=4-7 mph; leaves rustle, wind is felt on face

3=8-12 mph; leaves, small twigs in constant motion; light flag extended
4=13-18 mph; raises dust, leaves, loose paper; small branches in motion

You should not survey in any other conditions!

Temperature: (start and end)**:** Use °F (if you do not have a thermometer estimate to the nearest 5°)

Point Info

Private Property: Enter "Y" for yes and "N" for no for **EACH** point.

GPS Accuracy: Enter the level of accuracy that is displayed on your GPS screen (+/- X meters) when you arrive at each point. You must do this in the field for each point.

Other (Y/N)

Midstory Present: Record either Y or N to indicate the presence of several distinct layers of overstory vegetation.

Cliff/rock: Record either Y or N to indicate the presence of cliffs or large rocky outcrops within a 50-m radius of the count station

Prairie dog town (P-dog town?): Record either Y or N to indicate the presence of a prairie dog town. Abandoned towns should be marked as Y.

Prairie dog present (P-dogs present?): Record either Y or N to indicate the presence of prairie dogs. If you have reason to believe a colony is active, but they are all inside (excessive heat or cold), mark Y. Look for fresh sign such as scat or diggings.

Cheatgrass Present: Record either Y or N to indicate the presence of cheatgrass. Record Y if there is growth from the current year and/or if there is growth from the previous season.

Primary Habitat

Enter a two-letter code corresponding to the primary habitat type that best describes the 50-m radius surrounding the point. Refer to Figure SOP 2.3 for estimating cover within the 50-m radius. Please use the descriptions below as a guide:

Agricultural /Rural (AR): vegetation has been planted by humans for food production or ornamental purposes in sparsely developed areas. Examples include a farmed field with wheat, corn, millet, etc., a fallow field, a rural home site with planted non-native species, or a park planted with non-native species. Please make note of crop spp., if fallow, etc.

Aspen (AS): overstory dominated by aspen although scattered ponderosa pine or Douglas-fir may be present. The overstory cover should be ≥10% and consist of ≥50% aspen. Aspen stands often have an abundant and diverse shrub layer. Typical shrub species in aspen habitats include snowberry, willow, sagebrush, mountain mahogany, and oak. On occasion there may be no shrub layer. Typically the ground under aspen stands is covered by grasses and forbs.

Alpine Tundra (AT): high-elevation, open landscapes that occur above tree line. These areas should have ≤5% overstory and often lack a significant shrub component. Ground cover consists of short grasses (generally ≤10 cm in height), wild flowers, mosses, lichens, and succulents.

Barren (BA): area with little vegetation or rock present. These areas are typically characterized by large amounts of gravel, sand, silt, clay, or other earthen material and tend to be eroded. May include sand dunes, buttes, badlands formations, gravel pits, and desert pavement. The sum of live and dead grass must account for <10% of ground cover and shrub cover should be <10%. Exposed rock and boulders must make up <20% of ground cover (see Cliff/Rock). Barren habitat should not experience significant seasonal flooding (see Playa).

Burned Area (BU): forest habitat where ≥50% of canopy is dead and shows evidence of severe fire scars or where ≥50% of trees have burned and fallen.

Cliff/Rock (CR): area is dominated by rock and/or generally lacking vegetative cover (e.g., talus slopes, boulder fields, and rocky outcroppings). Areas described as Cliff/Rock should have ≤10% shrub cover and <10% canopy cover. Bare rock should make up ≥20% of the exposed ground cover.

Desert/Semi desert Shrubland (DS): dry landscape containing shrubs, but lacking a co-dominant grass component. % shrub cover should be ≥10. Shrubs often include sagebrush, greasewood, Fremont mahonia and saltbush. Sagebrush must comprise ≤30% of the shrub composition (see Sage Shrubland). Ground cover layer is typically dominated by bare ground and rock with limited forbs and grasses present. Grass and forbs make up ≤20% of ground cover (see Shrubland).

Deciduous Woodland (DW): habitat consisting of ≥10% canopy cover that is dominated by deciduous species other than Aspen or Oak species. Native deciduous species should comprise ≥50% of the canopy cover and Aspen or Oak spp. must comprise ≤50% of the canopy cover. The 50-m radius should not include a permanent or seasonal water source (see Riparian).

Grassland (GR): landscape lacking an overstory and significant shrub component. Ground cover is dominated by grasses and perhaps some forbs. Shrub component must be <10% (see Shrubland). The sum of live and dead standing grass must be ≥10%.

Historic Wetland (HW): land that was historically considered to be a wetland, but has since dried up. Wetland vegetation still dominates the landscape, although it is probably dried up and dead.

Insect Infested (II): forested habitat with ≥10% of the overstory composition dead or sickly, typically referring to pine and spruce bark beetles affecting several species of pine and spruce trees. Canopy cover must be ≥10%.

Jeffrey Pine (JF): areas with ≥5% overstory cover that is made up primarily of Jeffrey pine. This habitat often includes other tree types such as fir and Ponderosa pine, but Jeffrey pine should comprise ≥50% of the overstory layer. Shrub cover can vary from sparsely to heavily vegetated. Ground cover typically dominated by grass species.

Larch (LA): overstory dominated by larch although other coniferous and deciduous species may be present. The overstory cover should be ≥10% and consist of ≥50% larch.

Logged (LO): area within a forested habitat that has been recently logged. Overstory cover should be ≤10% (see a variety of forest primary habitats). Shrub cover should be ≤10% (see Shrubland). There should be little to no regrowth of shrub and/or overstory species. Ground cover typically consists primarily of grasses, stumps and dead and down timber.

Lodgepole Pine (LP): habitat consisting of ≥10% canopy cover that is dominated by lodgepole pine. Canopy may have other conifer species or some aspen, but lodgepole

pine must comprise ≥50% of the overstory cover. Shrub layer can be conspicuous or nearly absent.

Mesquite Bosque (MB): forested habitat surrounding riparian corridors that consists of ≥50% mesquite species. Canopy cover should be ≥10%. Ground cover typically consists primarily of grasses.

Mixed Conifer (MC): forested habitat consisting of several species of conifers, such as ponderosa pine, lodgepole pine, Douglas-fir, or spruce/fir spp. If the area is dominated by Douglas-fir, use Mixed Conifer as the primary habitat type. Canopy cover should be ≥10%. Overstory may range from very dense to relatively open. Undergrowth is complex and typically contains deciduous shrubs and/or conifer saplings. Stands with dense overstory may have little or no shrub and ground cover.

Montane Meadow (MM): areas with little to no overstory that are surrounded by forests. Elevations should be ≥2,133 m. Soils should be moist to wet with forbs or grass as the dominant ground cover. Canopy cover should be ≤10%. Shrub layer should be ≤10%.

Oak Woodland (OA): Habitat dominated by oaks (*Quercus* spp.), often accompanied by juniper, ponderosa pine, pinyon pine, or Chihuahuan Pine. The overstory and shrub cover must sum to ≥10% cover, with oak species making up ≥50% of that cover. In some instances there may be little or no overstory because the Oak species that are present are <3 m high. In southern Arizona this habitat code should be used for Madrean woodlands.

Open Water (OW): habitat consisting of ≥50% open water, bank, and shoreline. Any other habitat type may be present, but must be <50%.

Pinyon-Juniper/Juniper (PJ): vegetative communities largely influenced by pinyon pine, juniper, or a combination of the two species. The overstory and shrub cover must sum to ≥10%. Semi-arid conditions often produce a relatively short overstory. Juniper tends to dominate at lower elevations while pinyon dominates at higher elevations. Typically, shrub layer includes sagebrush, rabbit brush, oak, or mahogany. Ground cover is usually dominated by grasses with fewer forbs. In some instances there may be little or no overstory because the PJ that is present is <3 m high.

Playa (PL): Shallow, ephemeral wetland that experiences significant seasonal changes in semi-arid to arid climates, including the Great Plains. They are primarily filled by rainfall, although playas found in agricultural settings may also receive water from irrigation runoff. They often have high salinity or may be completely dry. Some wetland-loving plants like sedges or rushes may be present even when surface water is not present.

Ponderosa Pine (PP): areas with ≥5% overstory cover that is made up primarily of ponderosa pine. This habitat often includes other tree types such as fir, pine, and aspen, but ponderosa pine should comprise ≥50% of the overstory layer. Shrub layer relatively open and often includes common juniper, oak, cliffrose, and currants. Ground cover typically dominated by grass species. This code should be used even if there is a significant oak understory.

Riparian (RI): stands or strips of trees or shrubs near a permanent or seasonal water source. Typical tree and shrub species include cottonwood, box elder, maple, aspen, alder, and willows. Riparian areas are typically discrete habitats, often surrounded by coniferous forest, grassland, shrubland or sagebrush habitat. If riparian habitat is present within the 50m radius, this should be the primary habitat type.

Sage Shrubland (SA): habitat where grasses and shrubs are co-dominant and the shrub cover is ≥10%. Shrub species must consist of ≥30% sagebrush. Typical ground cover is dominated by grasses with limited forbs and bare ground.

Spruce-Fir (SF): coniferous forest that is dominated by spruce and fir species (typically occurring at elevations ≥2,133 m). Note that Douglas-fir is not a true fir species (see Mixed Conifer). Overstory cover should be ≥10% with spruce and fir species comprising ≥50% of the overstory cover. Variable understory typically includes shrubs and forbs with few grasses.

Shrubland (SH): landscape co-dominated by grass and shrub species. Shrub cover must be ≥10%. Sagebrush must be <30% of shrub layer (see Sage Shrubland). Typical shrub species include ceonothus, manzanita, sage, rabbitbrush, currant, skunkbrush, serviceberry, and plum. Grass and forbs should make up ≥20% of ground cover (see Desert/Semi desert Shrubland).

Urban/Residential (UR): areas highly impacted by human development in which ≥20% of the ground is covered by impermeable surfaces. Typically describing relatively dense development including houses, lawns, sidewalks, parking areas, and streets.

Wetland (WE): habitat influenced by permanent or seasonal flooding resulting in tall reeds, grasses, and/or cattails with little to no overstory. This habitat is defined by the presence of some emergent vegetation that is adapted to wet soils or inundation. Typical species include cattails, sedges, rushes, and sphagnum mosses. Overstories are limited to drier areas around the wetland and overstory cover should be ≤10%.

Whitebark Pine (WP): mid to high elevation habitat (>1,829 m) dominated by whitebark pine. The overstory cover should be >5% and consist of >50% whitebark pine.

Western Red Cedar (WR): habitat consisting of ≥10% canopy cover that is dominated by western cedar species including western redcedar, incense cedar, and Alaska cedar. Canopy may have other conifer or deciduous species, but cedar species must comprise ≥50% of the overstory cover.

Not Listed (XX): primary habitat type does not fall into any of the above categories. This code is generally used when working in a new study area that has habitat types not encountered previously on IMBCR surveys. Make sure you write notes in the margin on the right of the datasheet explaining what you think the primary habitat should be described as for this point.

Overstory Data

Anything 3 m or taller should be considered part of the overstory.

% Overstory: Estimate the *total* percent coverage of all overstory trees within a 50-m radius of the point count station. Use 1%, 5%, or multiples of 10% when estimating % overstory cover. If no overstory cover is present, record "0" for % overstory cover. Refer to Figure 6 at the end of this section for examples of what various cover percentages look like.

Overstory Mean Height: At each point count station, estimate the *average height to the top of the overstory trees* within a 50-m radius to the nearest 1m. Use a rangefinder to help gauge estimates. If no overstory cover is present, record "0" for mean canopy height.

# of Snags: Count the numbers of snags (trees that are completely dead) that are ≥3 m high and ≥15.2 cm dbh) within a 50-m radius of the count station. If there are so many

snags that counting every snag is logistically difficult (100+) count the snags within a quarter of the 50-m radius and multiply that number by 4 to get an estimate of the number of snags (if you count 78 snags in a quarter of the 50-m radius you would record 312 snags; 78 x 4). Please take the time to count all snags within the 50-m radius whenever possible and never record 100+, 200+, etc.

Species Composition: Identify the dominant tree species in the overstory and record the relative abundance (%) of the total overstory occupied by each species within a 50-m radius of each point count station; you can list up to five species. Record tree species on the datasheet using the correct two-letter vegetation code (see Appendix C for plant species codes). Use 1%, 5%, or multiples of 10% when estimating overstory composition. It is acceptable for the largest value to be something other than 1%, 5%, or a multiple 10% so that the overall species composition total equals 100%. Note that if only one tree species is present in the overstory the relative percent should be 100%, regardless of how much of the % overstory cover.

Note that Snags (including dead trees [DC or DD]), and burned trees (BU) should be considered part of the overstory species composition if they are ≥3 m tall. If you record dead trees (DC or DD) as one of the dominant overstory species, then you should have >0 snags recorded. However, if you have >0 snags recorded, you may not necessarily have dead trees (DD or DC) listed as a dominant overstory species IF there are 5 other species listed as dominant.

If you are able to identify an overstory species but it is not included on the list of codes, record "XX" on the datasheet. In the margin on the right, specify what XX equals. After the field season we can add this species and assign it a unique code. If you have multiple XX species, record XX_1, XX_2, and so on. If you come across a species you cannot identify, even after you've consulted your vegetation guide after the survey is over, record one of the unknown codes on your datasheet (UC for unknown conifer, UD for unknown deciduous, or OT for other).

Understory Data

Use this category to estimate the percent cover and species makeup of any woody vegetation (including seedling trees) that is ≥0.25 m high and <3.0 m high. Anything shorter than 0.25 m should be considered part of the ground cover category. Grasses, rushes, reeds, sedges, and herbaceous species should **not** be recorded in the understory layer regardless of height. Instead, they should be recorded in the ground cover section. If the point you are surveying is in cropland, please specify whether it is bare (plowed), fallow, or active (and indicate crop species if known). Write these data in across the applicable row for the point in the Understory Layer section.

Understory Cover: Estimate the total percent coverage of all woody shrub species AND seedling trees present within 50 m of the count station. Use 1%, 5%, or a multiple of 10% to estimate the % understory cover. If no understory cover is present, record "0" for % understory cover. Refer to Figure 4 for examples of what % covers look like.

Mean height: Estimate the average height to the nearest 0.25 m of the understory layer. If no understory cover is present, record "0" for understory height.

Species composition: Identify the dominant understory species (including seedling trees) present and record the *relative* abundance of the total understory layer occupied by each species within a 50-m radius of each point count station; you can list up to five species. Record understory species on the datasheets using the correct two-letter vegetation code (see Appendix B for plant species codes). Use 1%, 5%, or multiples of 10% when estimating understory layer composition. It is acceptable for the largest value to be something other than 1%, 5%, or a multiple 10% in order for the sum of the species composition to equal 100%. Note that if only one understory species is present, the relative percent should be 100%, regardless of how much of the circle the species occupies.

Note that dead trees (DC or DD), and burned trees (BU) should be considered part of the understory species composition if they are ≥0.25 m and < 3 m tall.

If you are able to identify an understory species but it is not included on the list of codes, record "XX" on the datasheet. In the margin on the right, specify what XX equals. After the field season we can add this species and assign it a unique code. If you have multiple XX species, record XX_1, XX_2, and so on. If you come across a species you cannot identify, even after you've consulted your vegetation guide after the survey is over, record one of the unknown codes on your datasheet (UC for unknown conifer, UD for unknown deciduous, or OT for other).

Ground Cover Data

We classify ground cover into nine categories. For each of these categories, estimate the total percent of ground cover within 50 m of the count station. Use 1%, 5%, or multiples of 10% when estimating % ground cover. It is acceptable for the largest ground cover value to be something other than 1%, 5%, or a multiple 10% in order for the sum of the ground cover to equal 100%. We also record the average height for dead standing grass, and for live grass **and** herbaceous plant height.

The ground cover data collected are:

> **Snow**
> **Water**
> **Woody**: vegetation below 0.25 m including cacti.
> **Dead and down**: trees (with a minimum dbh of 15.2 cm) which do not reach 0.25 m tall at their highest point.
> **Herbaceous**: broad-leaved herbaceous plants and forbs.
> **Dead standing grass**: includes grass, rushes, reeds, and sedges that are no longer alive and are clearly from the previous year's growing season.
> **Live grass**: includes grasses, rushes, reeds, and sedges that are still green or are clearly from this year's growing season. Note: wheat is a grass and should be factored into the % live grass cover.
> **Litter**: % of ground covered by any type of organic litter such as, leaves, needles, bark, dead grass, and all woody debris with a dbh <15 cm.
> **Bare**: % of ground covered by inorganic materials such as dirt, rocks, pavement and sand.

Dead standing grass height: estimate the average height of all dead grass (including rushes, reeds, and sedges) that are no longer alive and are from the previous year's growing season. Estimates should be to the nearest centimeter and include all dead grass within the 50-m radius. Note: wheat stubble should be considered dead standing grass and factored into estimating the dead standing grass height.

Grass and herbaceous height: estimate the average height of the living grass species **AND** all herbaceous plants to the nearest centimeter within the 50-m radius. You should use your datasheet (21.5 cm x 28 cm) or pencil (15 cm) to help you estimate.

Note: Please put a "0" in the box for any ground cover category that is absent from the 50-m circle, rather than leaving it blank. If no dead standing grass cover is present, record a "0" for dead standing grass height. If no live grass **OR** herbaceous cover is present, record a "0" for grass and herbaceous height.

IMBCR Point-Transect Form

Observer (Login ID)	Date (YYYY/MM/DD)	Refuge	BCR	Transect ID	Time	0502	0940
Someone	2018/06/12	Somewhere	16	CO-BCR16-BL19	Sky	2	1
					Wind	0	1
					Temp	45	65

Overstory – all spp. total to 100%

Point	Private property?	GPS Accuracy	Point	Midstory Present	Cliff/rock?	P-dog town?	P-dogs present?	Cheatgrass?	Point	Primary Habitat	% Overstory	Overstory Mean Height	# Snags	Species #1	Sp 1 % cover	Species #2	Sp 2 % cover	Species #3	Sp 3 % cover	Species #4	Sp 4 % cover	Species #5	Sp 5 % cover
1	N	4	1	N	N	N	N	Y	1	MM	10	16	3	L P	99	D C	1						
2	N	3	2	N	N	N	N	N	2	MC	50	17	0	L P	50	S U	50						
3	N	3	3	N	N	N	N	Y	3	LP	30	16	1	L P	79	S U	20	D C	1				
4	N	2	4	Y	N	N	N	Y	4	AS	10	14	#	A S	60	L P	30	D C	5	D D	5		
5			5						5														
6			6						6														
7			7						7														
8			8						8														
9			9						9														
10			10						10														
11			11						11														
12			12						12														
13			13						13														
14			14						14														
15			15						15														
16			16						16														

Understory layer – all spp. total to 100%

Point	% Shrub Cover	Shrub Mean height (m)	Species #1	Sp 1 % cover	Species #2	Sp 2 % cover	Species #3	Sp 3 % cover	Species #4	Sp 4 % cover	Species #5	Sp 5 % cover
1	5	1	C J	90	L P	10						
2	5	1	C J	70	L P	20	S U	10				
3	5	1	L P	60	C J	40						
4	10	3	L P	40	C J	30	A S	20	G B	10		
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												

If found, please mail to:
Bird Conservancy of the Rockies
230 Cherry St, Fort Collins, CO
Or call: (970) 482 - 1707

Ground Cover – totals to 100%

Points	% Snow	% Water	% Woody	% Dead and Down	% Herbaceous	% Dead Standing Grass	% Live Grass	% Litter	% Bare	Dead Standing Grass Height (cm)	Live Grass & Herb. Height (cm)
1	0	0	5	1	20	10	10	34	20	7	16
2	0	0	10	10	5	1	1	53	20	9	16
3	0	0	10	5	5	5	5	60	10	8	17
4	0	0	10	10	5	1	1	63	10	8	14
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											

Figure SOP 2. 1. Example of a partially completed habitat datasheet.

Points Not Completed

There is a simple datasheet on the back of the habitat datasheet (Figure SOP 2.2) with 16 lines on it to record a reason why you were unable to survey a point. Values that can be entered for

reasons points were not conducted are listed below from highest importance to lowest importance. If more than one code applies, please record only the code of highest importance (e.g., if you couldn't cross a river, but also ran out of time to survey a point you would record only R: can't cross River).

You may run into unexpected issues in the field preventing you from conducting a point count. For these instances record "O" for "Other" and be sure to take detailed notes on why the point was not conducted. We need to report this information to our funders after the field season, so the more information you provide us, the less we will have to contact you with questions after the field season.
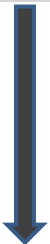
Point	Reasons points were not conducted. If O, provide an explanation below.
1	
2	
3	
4	
5	
6	
7	
8	*R*
9	
10	
11	
12	
13	
14	
15	*T*
16	*T*

Observer ID			Year					Transect ID	
Someone			2	0	*1*	*8*		*CO-BCR16-BL19*	

Order of Importance	Please record the reasons why you did not survey certain points within the grid (if applicable). If more than one of the codes below apply, please record ONLY the code of highest importance.	
Most	P:	Private Property - Denied **P**ermission
	N:	Private Property - **N**o contact with landowner
	U:	Terrain **U**nsafe (could not safely approach to within 25 m of point)
	R:	Can't cross **R**iver
	S:	**S**now pack impassible
	H:	Running water near point - unable to **H**ear
	W:	**W**eather (rain or wind)
	G:	No **G**PS reception, cannot find point
	T:	Ran out of **T**ime (five hours past sunrise or noticeably decreased bird activity)
Least	O:	**O**ther - explain

Figure SOP 2. 2. Backside of habitat datasheet.
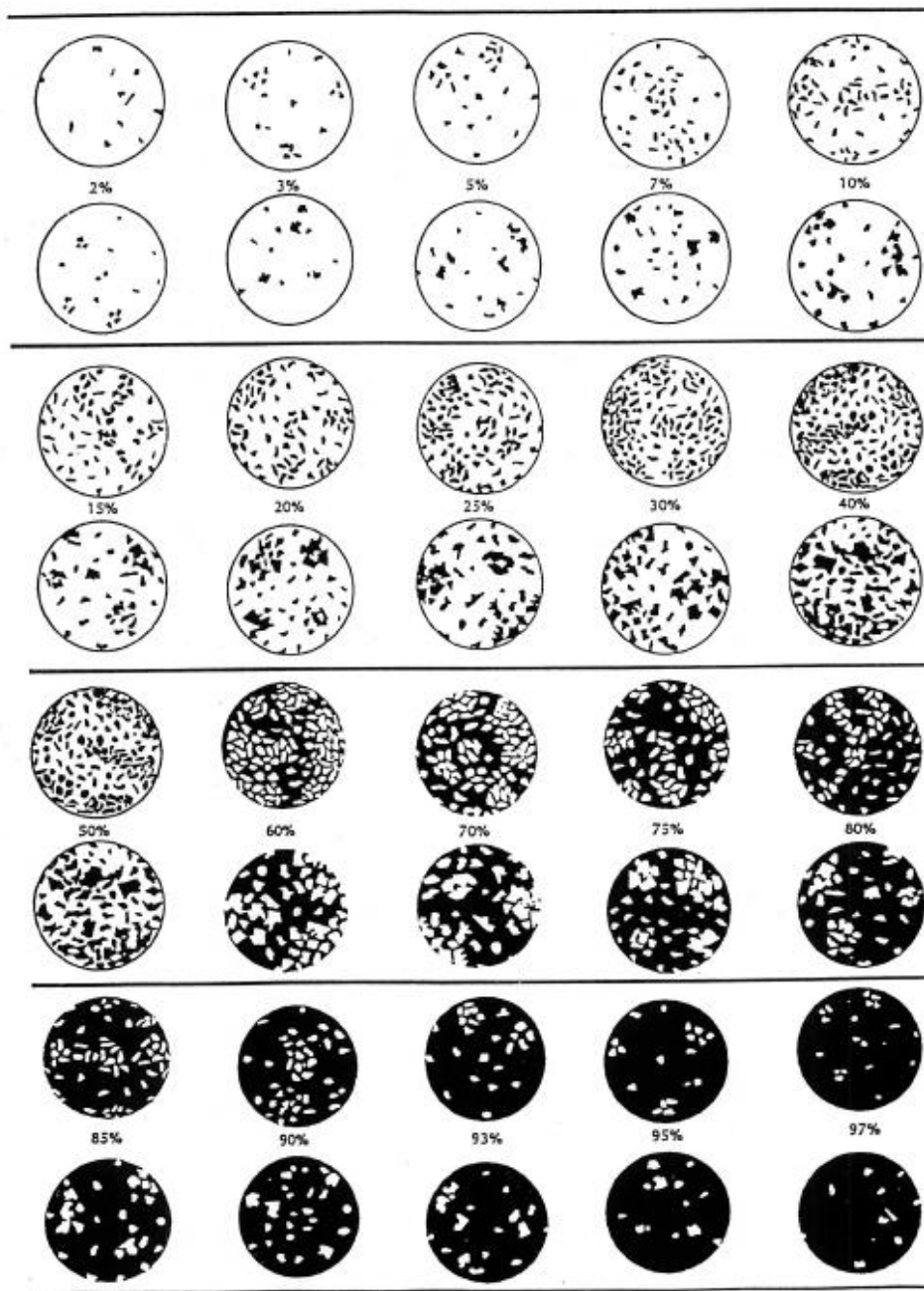
Figure SOP 2. 3. Examples of percent cover taken from Barry, Sheila. 1994. Monitoring Vegetation Cover. Alameda County Resource Conservation District, 1996 Holmes St., Livermore, CA 94550.

Bird Data

After filling out the habitat datasheet, enter the number of the point (01-16) on the transect you are about to survey on the bird datasheet (Figure SOP 2.4). **NOTE:** for entries of species

detected *between points* leave a blank row on the datasheet and enter "88" as the minute (see below for more information on "88" birds). After recording the general habitat data at the point count station and denoting the point you are at on the bird datasheet, record the time next to the point number in military format, using Mountain Daylight Time (MDT) regardless of the time zone you are in. At training, you will be instructed on how to set the clock on your stopwatch to MDT, and you will refer to that clock when recording time.

Once you have recorded the time and the point you are about to survey, activate your timepiece and begin recording the birds you see and hear. The count duration is six minutes. It is extremely important to document the minute of the count that an individual bird was <u>first</u> detected. To do this, simply write the number of the minute under the "minutes" column each time the beeper goes off. DO NOT record any birds after the six minutes are over, even if it is an interesting bird. If you do not detect any birds during a minute interval, record "NOBI" (No Birds) for that interval. Please make certain that your time piece's beeper is on and functioning correctly as it is impossible to pay attention to the birds and note how much time (by looking at your time piece) has passed simultaneously. If, during your six minute survey, you detect a bird that was flushed from the survey point upon your arrival (before you began the six minute survey), record the bird's original distance from the survey point, because we assume that these birds would have remained at their original locations were it not for the disturbance created by the observer.

While conducting counts, be sure to focus primarily on birds that are close to the point. Although we do ask you to record all birds detected, distant birds have little effect on density estimates. However, missing close birds can have a significant effect on density estimates. **Note:** Do not use a scope when conducting point counts. It is more important to focus on and accurately record birds that are close to you rather than those that are far away. Binoculars will be sufficient for visual bird identification.

Be sure to look and listen in all directions, including up. It is best to slowly rotate in place while you are counting; making three complete turns in the six minutes is probably adequate. **Don't forget to look up!** It is very important to stay in one place while counting. It is acceptable to take a step or two away from where you are conducting the point in order to identify a bird that you have detected from the point but ***ALWAYS*** return to the point as soon as possible. Do not chase birds before or during the count. After the six minutes are up, you may chase down a bird that you couldn't identify during the six minute count in order to get an identification, but do not leave the point during the six minutes and do not record birds for the count that were only detected while chasing another bird after the count. **Remember**: Consistency of methods and coverage is the key to useful data!

Be aware of what is going on around you and realize that you may hear or see individual birds on multiple points. It is okay to record the same bird on multiple points as long as the bird is not moving in response to your presence. For example, if you see a Western Meadowlark on a power line, and that same Western Meadowlark is visible at the same location from the next two points, you would record it on all three point counts. Additionally, if you see a Red-tailed Hawk soaring above you, and still see the hawk soaring on another point, you would record it on both points. However, if you survey three points along a fence and as you move between points a Loggerhead Shrike keeps moving away from you and re-perching on the fence, you should record that bird

on the first point only. Additionally, you should mentally track birds that may move around you during a point so as not to double count them during a single six-minute count.

For each independently detected bird, you will record:

> **Start Time**
> **Point Number**
> **Each minute during the count**
> **Species, using 4-letter codes**
> **Radial Distance (m) to each bird**
> **How the bird was detected**
> **Sex of the bird**
> **If the bird was visually identified**
> **If you believe the bird is a migrant**
> **The cluster size and cluster ID code.**

Please refer to Figure SOP 2.4 at the end of this section for an example of a completed bird data form.

Start time
Record the start time (in Mountain Daylight Time) at each point count location next to the point number before you start your count.

Point Number
Enter the number of the point on the transect-you are about to survey. Indicate the start of a new point by leaving a blank line on the datasheet and recording the next point number. If observations from one point span multiple pages, be sure to include ("cont.") next to the point number at the top of the next page. **NOTE**: for birds detected between points that have not been recorded on previous points, record "88" for the point number (see below for more information).

Minute (1-6)
Record the minute you are in during the six minute count. Minute 1 is from 0-60 seconds. Your timer will beep each minute to let you know when the next minute interval has begun.

Species
All birds detected during the six-minute count period will be recorded using the correct four-letter codes (see Appendix C. Four-Letter Bird Codes for bird species codes. Please commit to memory codes that do not follow the general code convention). If you ever record a bird and are unsure of the four-letter code, make a note with the full species name in the notes section at the bottom of the page to avoid confusion later.

PLEASE use correct codes, as it makes data entry, proofing, and analyses easier. Species that cause particular problems for observers include: **Cackling Goose** (CACG not CAGO), **Canada Goose** (CANG not CAGO), **Northern Shoveler** (NSHO, not NOSH), Ring-necked Pheasant (RINP, not RNPH), **Barn Owl** (BNOW not BAOW), **Barred Owl** (BDOW not BAOW), **Broad-tailed Hummingbird** (BTLH not BTHU), **Western Wood-**

Pewee (WEWP, not WWPE), **Gray Jay** (GRAJ, not GRJA), **Tree Swallow** (TRES, not TRSW), **Bank Swallow** (BANS, not BASW), **Barn Swallow** (BARS, not BASW), **Cactus Wren** (CACW not CAWR), **Canyon Wren** (CANW not CAWR), **Cedar Waxwing** (CEDW not CEWA), **Black-throated Gray Warbler** (BTYW not BTGW), **MacGillivray's Warbler** (MGWA, not MAWA), **Canyon Towhee** (CANT not CATO), **Lark Bunting** (LARB, not LABU), **Sage Sparrow** (SAGS not SASP), **Savannah Sparrow** (SAVS, not SASP), **Lazuli Bunting** (LAZB, not LABU) and **Red-winged Blackbird** (RWBL, not RWBB).

Some individuals can be identified to subspecies. If you are able to visually identify an individual to subspecies use the four-letter codes below. Please do not make assumptions regarding which subspecies you detected (i.e., you need to visually identify individuals to subspecies).

Table SOP 2. 2. Four-letter bird code for common subspecies detected during point count surveys.

Subspecies	Code	Subspecies	Code
Dark-eyed Junco (Gray-headed)	GHJU	Northern Flicker (Yellow-shafted)	YSFL
Dark-eyed Junco (Oregon)	ORJU	Northern Flicker (Intergrade)	FLIN
Dark-eyed Junco (Pink-sided)	PSJU	Northern Flicker (Red-shafted)	RSFL
Dark-eyed Junco (Red-backed)	RBJU	White-crowned Sparrow (Gambel's)	GWCS
Dark-eyed Junco (Slate-colored)	SCJU	White-crowned Sparrow (Mountain)	MWCS
Dark-eyed Junco (White-winged)	WWJU	Yellow-rumped Warbler (Audubon's)	AUWA
Yellow-rumped Warbler (Myrtle's)	MYWA		

If you detect a bird that you are unable to identify, use the appropriate unknown bird code. Never guess on the identity of a bird. This is falsifying data. If you are unsure, we would prefer you to record "UNBI" rather than incorrectly identify a bird. However, recording a lot of unidentified birds is an indication that you need to study and practice before performing more point counts. Below is a table of unidentified bird codes you can use:

Table SOP 2. 3. Four-letter codes for unknown birds detected during point count surveys.

Unknown Bird	Code	Unknown Bird	Code	Unknown Bird	Code
Unknown Accipiter	UNAC	Unknown Gnatcatcher	UNGN	Unknown Raptor	UNRA
Unknown Bird	UNBI	Unknown Grosbeak	UNGB	Unknown Raven	UNRV
Unknown Blackbird	UNBL	Unknown Grouse	UNGR	Unknown Sandpiper	UNSA
Unknown Buteo	UNBU	Unknown Gull	UNGU	Unknown Sapsucker	UNSS
Unknown Cardinal	UNCA	Unknown Hawk	UNHA	Unknown Sparrow	UNSP
Unknown Chickadee	UNCH	Unknown Hummingbird	UNHU	Unknown Swallow	UNSW
Unknown Cormorant	UNCT	Unknown Jay	UNJA	Unknown Swift	UNSI
Unknown Corvid	UNCO	Unknown Kingbird	UNKI	Unknown Tanager	UNTA
Unknown Cowbird	UNCB	Unknown Longspur	UNLO	Unknown Tern	UNTE
Unknown Dove	UNDO	Unknown Meadowlark	UNME	Unknown Thrasher	UNTR

Unknown Duck	UNDU	Unknown Myiarchus	UNMY	Unknown Thrush	UNTH
Unknown Empidonax	UNEM	Unknown Nuthatch	UNNU	Unknown Towhee	UNTO
Unknown Falcon	UNFA	Unknown Oriole	UNOR	Unknown Vireo	UNVI
Unknown Finch	UNFI	Unknown Owl	UNOW	Unknown Warbler	UNWA
Unknown Flicker	UNFR	Unknown Pipit	UNPI	Unknown Woodpecker	UNWO
Unknown Flycatcher	UNFL	Unknown Quail	UNQU	Unknown Wren	UNWR

If no birds are detected during a one-minute period, enter "NOBI" (No Birds) in the space for four-letter bird codes. If no birds are detected during a six minute count, you should have six time periods recorded, each with "NOBI" written next to it. Recording "NOBI" will help you keep track of your minute intervals, and the data will reflect that you did conduct a full six minute count.

Distance

Using your rangefinder, measure the distance from the point count station to each and every individual bird detected during the count and record the distance in meters on the datasheet under "Radial Distance". If you detect a bird at one kilometer (1,000 m) or beyond, enter the distance as "999". Please note that we record radial (horizontal) distance, not straight line distance. For example, if you detect a bird singing in a tree directly above you, the distance would be 0 m, not how far the bird is above you.

You should measure all distances to birds using your rangefinder. If you cannot get a direct line of sight to the location of a bird, estimate the distance that bird is from a visible point and use the rangefinder to measure to that point. Then add or subtract the additional estimated distance between that point and the bird to obtain the best possible distance estimate from the point to the bird. Please estimate the distance from the visible point to the bird BEFORE using the rangefinder to get the distance from you to that point. Distance sampling relies upon the assumption that you measure all distances accurately, so use your rangefinder to determine a distance for every bird detection!

Always measure distances to where you first detected the bird, not to where you first identified it. For birds that are vocalizing but not seen, try to pinpoint their locations to a specific tree/bush, then measure the distance to that object. If you see or hear a bird that is beyond the range of the rangefinder, estimate the distance the bird is past a point that is within-range of your rangefinder and add that distance to what the rangefinder displays. Once again, estimate the distance between the bird and point-within-range BEFORE using the rangefinder to get the distance from you to that point. Add your estimate plus the measured distance and record the sum as the total distance.

Every bird recorded on point counts must have a radial distance measurement associated with it! This is imperative. Because our monitoring programs rely on Distance-sampling techniques and analyses, bird data recorded without associated distances CANNOT be used in analyses! We will further explain the premises behind Distance-sampling during training. But please, please, please do not forget to measure and record radial distances for EACH bird recorded on point counts.

How

In the "How" column (how detected), record how each bird was detected (i.e., V=visual, C=calling, S=singing, D=drumming, F=Flyover, or O=other aural (e.g. wing beats). Enter the code for how you **first** detected each individual in the upper left portion of the box. Remember that how you detect a bird may be different from how you identify it.

It is important for us to know when birds sing because it is a strong indicator that the individual is holding a breeding territory (and thus, potentially a breeding species in the study area). If you first detect a bird by means other than it singing and that same individual later sings, neatly write an 'S' in the lower right portion of the 'How' box. Note, "S" is the only valid detection code in the lower right portion of the "How" box.

Flyovers: A bird observed flying over a point without showing any signs of using the surrounding habitat should be recorded as a "flyover". However, individuals of species that habitually hunt on the wing (e.g., raptors, swallows, swifts) or appear to be foraging (e.g., crossbills, goldfinches, waxwings) in the vicinity of the point should NOT be treated as flyovers. Just because a bird is flying does not make it a flyover. Additionally, individuals that you first detect in flight that are simply flying from perch to perch nearby should NOT be recorded as flyovers. For true flyovers, enter an "F" in the "How" column.

Sex

In the "Sex" column, record the sex of the bird (M or F) if you visually observe a sexually dimorphic species and can identify the sex of the individual. If you are unable to visually observe the bird, or if the bird is of a species that does not exhibit sexual dimorphism, record the sex as "U" for unknown. Change the "U" to "M" or "F" if you later identify the same individual as male or female. Females of many bird species sing at least occasionally, and female singing behavior of many species is poorly understood, so please do not assume that singing birds are males.

If you record a bird and visually identify it as a juvenile, record "J" in the Sex column. The surveys we conduct are for breeding birds and juveniles do not fall into this category. Recording birds as juveniles will allow us to remove these birds from analyses while retaining proof of breeding behavior for the location.

Example: On a point count, you detect six birds. You see a male RNSA, you hear a RNSA calling, you hear a calling WBNU, you see a male AUWA that later sings, you hear a singing CHSP, and you see a brown-plumaged CAFI. In order, the "How" column should be filled in with V, C, C, V/S, S, and V. Fill in the "Sex" column: M, U, U, M, U, and U respectively (male CAFI require two years to achieve adult plumage, thus a brown-plumaged bird cannot be sexed in the field).

Visual

In the "Visual" column enter a checkmark if you were able to visually identify the individual at any time during the survey. Check this box even if you recorded "V" for the detection type. This column is meant to further assure crew leaders and partners of proper identification. You may also check this box if you visually identify the individual before,

during or after the point count. **Note**: If a bird was detected visually but identified by another means AND you were never able to positively identify the individual by sight then do NOT check the visual checkbox.

Migrating?
In the "Migrating?" column enter a checkmark if you have reason to believe the detected individual is not on its breeding territory. Clues that a bird may be migrating through are: 1) the bird is in a large flock 2) the bird is in unusual habitat that differs substantially from where it is typically found during the breeding season (e.g., a Brewer's Sparrow that is detected in a desert environment with no sagebrush) or 3) the bird is outside of its typical breeding range.

Cluster Count/Cluster ID
"A cluster is a relatively tight aggregation of objects of interest…" (Buckland et al. 2001). In our point count sampling, clusters are actually our unit of observation, with most cluster sizes = 1. There are generally two cases in which cluster sizes are > 1; single species flocks and paired birds. In order for multiple birds to be considered a cluster, they must:

1. Be of the same species;
2. Be detected during the same minute interval during a point count;
3. Be within 20 m of one another;
4. Not be two singing males.

The Cluster Code is only used to link clusters that take up multiple lines on the datasheet.

Please record the two types of clusters as follows.

Flocks: When two or more individuals of the same species are obviously in a flock and cannot be readily sexed (e.g., Cliff Swallow or Pine Siskin), record the distance to the center of the flock and record the number of individuals in the "Cluster Size" column of your data form. You do not need to enter a Cluster Code. When you can determine sex, enter the number of males on one line, and the number of females on the next line, with the appropriate number of each sex in the corresponding "Cluster Size" boxes. Then enter the same letter on both lines for the "Cluster Code" (a, b, c …). The Cluster Code is only used to link clusters that take up multiple lines on the datasheet.

Pairs: Often you may hear a bird singing or calling, look up, and see that it is a male bird with a female perched or foraging nearby. Alternatively, you may see one individual moving about, raise your binoculars to identify it, and observe that there are actually two individuals of the same species but opposite sex in that location. In these cases, enter the male and female on separate lines of your datasheet, with the appropriate codes for "HOW" detected and "Sex". In the first scenario, the male "HOW" = S(inging) and the female "HOW" = V(isual). In the second scenario, "HOW" = V(isual) for both the male and female. In both cases enter the same letter for the "Cluster Code" of each member of the pair (a, b, c …).

Example: After recording a Western Tanager (WETA) and an American Robin (AMRO) on a point count, the observer hears a Black-headed Grosbeak (BHGR) give its distinctive squeaky call note. The observer turns to see the bird and notes that the calling bird is a male BHGR 27 m away AND also notes that there is a female BHGR in the same tree, but about 29 m away. Next, the observer hears five Pine Siskins (PISI), looks up, and measures that they are 36-38 m away. Finally, the observer hears a Mountain Chickadee (MOCH) calling, looks up and sees that MOCH as well as a second MOCH in the same tree; both at 17 m away. The sex of both individuals is unknown, but the method of detection differs, so they should be recorded on separate lines with a common Cluster Code. The observer's data should look like Table SOP 2.4.

Table SOP 2. 4. Example datasheet for breeding birds recorded during a point count survey.

Time	Point #	Minute	Species	Radial Distance	How	Sex	Visual	Migrant?	Cluster Size	Code
0552	03	1	WETA	46	S	M	X		1	
			AMRO	103	S	U			1	
		2	BHGR	27	C	M	X		1	A
			BHGR	29	V	F	X		1	A
		3	PISI	37	C	U	X		5	
		4	NOBI							
		5	MOCH	17	C	U	X		1	B
			MOCH	17	V	U	X		1	B
		6	NOBI							

Mammals

Yes, mammals. In an effort to incorporate other information into our bird monitoring programs, we are also collecting data on red squirrels (RESQ), Abert's squirrels (ABSQ), and Pika (PIKA) during point counts. Treat these three mammal species as you would a bird on point counts (fill in the radial distance, how, sex, and visual boxes). Please do not forget to record these mammals **and** their associated data at all point counts, as the utility of these data depend on everyone collecting them throughout the study areas.

"88" Birds

It is important to track occurrences of all species at each transect. This is especially important for rarer species that may not be detected during an actual survey at a point count location. To do this we document detections of species that we have not detected while actively conducting point counts on the transect (these are detections that occur while collecting vegetation data, walking between points, etc.). In order to ensure that the detection occurred on the transect grid, you should only record "88" birds after completing the first point count and before beginning the last point count of the morning. Please do not record "88" birds that you detect while approaching the transect in the morning or after finishing your last point count. To record an "88" bird, leave a single blank row between your last point count detection and record the Species Code, How, Visual, Migrant? and Custer Size for the "88" detection. You do not need to record distance for these detections.

66

If you record an "88" bird and then subsequently detect that individual on a point count, please cross out the "88" detection.

If you encounter a rare or unusual species before or after you've started surveying, you should record this information in the notes section at the bottom of the bird data page (see next section). You will need to record the Species Code, UTM coordinates, and your distance to the nearest point count station.

Transect notes
Enter information relevant to the site or individual points in the notes section at the bottom of the datasheet. This is a good place to record problems encountered during the survey, or anything that may have affected your point counts (loud noises, cows, etc.)

This is also the location to record notes regarding rare or unusual birds. It is very important to make notes about rare or unusual birds because after the field season, Bird Conservancy staff review the data and look for any detections that seem odd or out of place. If you positively identify a species that you believe may be questioned later, it is helpful to write notes to affirm your detection. Useful notes regarding a rare species should include information regarding key field marks (both visual and/or auditory), the age and sex of the bird, how you differentiated the rare species from other, similar, species and any relevant information regarding behavior and/or weather conditions.

When entering data into the database, don't forget to look through the notes sections on your datasheets. Notes that are useful to someone surveying next year should be entered on the transect description page.

VERY IMPORTANT
Check over your point count data before leaving each count station to make sure you have recorded all the required information (e.g. distances, how, sex, etc.). Skip a line between entries for individual points. All individual birds on a particular point should be bunched together on the form; then you should leave a blank line before starting entries for the next point.

USFWS Landbird Survey Data

Observer	Date (YYYY/MM/DD)	Refuge	BCR	Transect Name
SOMEONE	2 0 1 3 0 6 1 2	SOMEWHERE	1 6	CO-BCR16-BL19

How: V=visual; S=singing; C=calling; F=flyover; D=drumming; O=other aural detection

Between points: point # = 88 — Sex: M=male; F=female; U=unknown; J=juvenile

Start Time	Point #	Minute	Species	Radial Distance (meters)	How Detected	Sex	Visual?	Migrating?	Cluster Size	Code
0457	01	1	HOLA	0 7 1	s	u				
			LISP	1 2 2	s	u				
		2	STJA	1 8 6	c	u	✓			
		3	AMRO	0 0 4 6	c	f	✓			
			CLNU	1 1 3	c	u	✓			
		4	NOBI	—						
		5	CORA	1 7 7	v	u	✓			
		6	HOLA	1 0 8	s	u				
0511	02	1	DEJU	0 4 0	s	u	✓		1	A
			DEJU	0 4 1	v	u	✓		1	A
			RCKI	0 8 3	s	u				
		2	TOSO	0 4 2	s	u				
			DEJU	0 6 4	s	u				
		3	MOCH	0 3 4	c	u			2	
		4	NOBI	—						
		5	HETH	1 1 3	s	u				
		6	NOBI	—						
	88		BRCR		s	u				
0522	03	1	DEJU	0 5 4	s	u				
			DUFL	0 4 1	s	u				
			HAWO	1 2 7	D	m	✓			
		2	MOCH	0 1 7	c	u				
		3	YRWA	0 7 2	c s	u				
		4	YRWA	0 8 5	s	u				
		5	NOBI	—						
		6	AMRO	1 3 6	F	u	✓		3	

Notes:

Figure SOP 2. 4. Example of a partially completed landbird survey datasheet.

References

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, UK.

Hanni, D. J., C. M. White, J. J. Birek, N. J. Van Lanen, and M. F. McLaren. 2012. Integrated Monitoring in Bird Conservation Regions (IMBCR): Field protocol for spatially-balanced sampling of landbird populations. Unpublished report. Rocky Mountain Bird Observatory (now Bird Conservancy of the Rockies), Brighton, Colorado, USA.

Standard Operating Procedure 3: Data Entry

Entering Data
Data should be entered by the individual conducting each survey or another designated individual either during or promptly after field season has ended. If time allows, it is helpful to enter data in the afternoon after morning surveys are completed. In order to enter data collected during a survey you will need to open the data entry folder that was provided to you by your Bird Conservancy primary contact and then open the "index.htm" file in Firefox. The first time you use the data entry program you will need to be online so that the program can download the necessary files from the database. Once the program has downloaded the files, you can enter data either on or offline. Bird Conservancy staff can also enter a refuge's data if there is a pre-arranged agreement. A refuge biologist should discuss an arrangement with the primary contact ahead of the field season.

Installing and Updating the Data Entry Application
Installation
When your primary contact sends you the zipped data entry application folder, right-click on the zipped folder and select "Extract Files" or "Extract All". Set the destination to your Desktop and hit OK. You should now have a folder called "Data Entry" saved on your desktop. **Note: Make sure your Firefox browser is not set to automatically clear browsing history. The data you enter will actually be stored within the browsing history in Firefox, so if you clear your browsing history at any point you will lose any data you've entered but not submitted to the database.**

Updates
The data entry application can go through periodic changes during the field season to improve compatibility for all avian monitoring programs and to increase functionality. The data entry system has been designed to notify users if a new version is available when the program is opened. If, while you are online, you receive a notification (pictured right) that there is a new version of the data entry site available, please follow these steps to update the app:

      1. Hit OK.
      2. Another window will pop up to reconfirm the update. Hit OK again.
      3. A pop-up blocker notification may appear on the top of the screen. Click on the pop-up blocker notification, select "Options", and select "Show http://rmbo.org/v2..."
      4. Select "Save File" and Hit OK.
      5. Close the Firefox browser containing the data entry application.
      6. Extract the new Data Entry files, setting your Desktop as the destination folder.
      7. If done correctly, another window will pop up asking if you want to replace the old Data Entry folder with the new one. Select "Yes" every time it asks you if you want to replace a file within the folder (or "Yes to All" if that's an option).

NOTE: The take away message here is to **replace the old Data Entry folder with the new Data Entry folder**, no matter what you have called it or where it is saved. By saving the latest version to the same location on your computer, your browser will retain links to any saved transects that you have previously entered and you will not lose any data.

Data Categories
The data entry can be broken up into 4 major sections:

Transect Visit Data
Observer, transect name, date, start and end times, sky, wind, temp, etc.

Point Visit Data
The points visited during the survey, point count start times, GPS accuracy, reasons points were not surveyed

Vegetation Data
Vegetation and other point information such as the presence/absence of prairie dogs

Bird Data
Species recorded at the point and information related to the observation such as detection type, sex, distance from observer, etc.

Entering Data
Survey Data
Transect Visit Data, Point Data, Vegetation Data, and Bird Data should all be entered by opening the browser file inside the Data Entry folder entitled "index.html" with Firefox. If Firefox is not your default browser, right-click on the index.html file→Open with→Firefox. You can also set Firefox to be the default browser for that file (right-click→Open with→Choose default program).

Survey data can be entered offline and then subsequently uploaded into Bird Conservancy's database. BE SURE to upload any data that you enter as soon as you have internet access; otherwise, your data entry efforts may be lost (since no one else can upload the information you've entered without your computer).

The occasion may arise where the data recorded on the datasheet seem incorrect or are missing. Under no circumstances should you enter any values other than those recorded on the datasheet or those values which are designated below to indicate "missing values". If you run into a problem where you must enter a value and do not know what to enter, please contact your primary contact at Bird Conservancy.

When entering data, we recommend that you use the "Tab" button to move from one field to the next across rows. To return to the previous cell you can use "Shift + Tab".

Getting Started
The first time you open the index.html file you will need to be online so that the program can download the necessary files from the database. Once the program has downloaded the files, you can enter data either on or offline. Upon opening the index file you will be prompted to select from the following options:

- Data Entry Mode: IMBCR, IMBCR (variable points), Parks, Tamarisk, Habitat, or Wintering Grasslands.
- Language: English or Spanish
- Species code mode: 4 or 6
- Vegetation code mode: 2 or 6

At training, an IMBCR trainer will instruct you on which mode you should use for your project, likely IMBCR or IMBCR (variable points). Select the desired mode and then click "Load". Next, you should select either "New Visit" or "Saved Transects". If you are entering data for a new transect select "New Visit". If you are going to be entering data for a transect that you have already started entering data for, select "Saved Transects". If you need to enter data for a transect that you or someone else already started entering and you don't have that transect available from your list of saved transects, you will need to contact your Bird Conservancy primary contact for a data editing password. With that password you can access transect data that resides within the database.

When entering survey data offline, the information you enter is actually saved within the Firefox browser. This means that if you clear your browser history, you will lose any saved data not yet submitted to the database. We recommend that you check your browser settings and make sure you do not clear your browser history until you have successfully uploaded all your data to the online database. Go to Options→Privacy Tab and in the History section, set the "Firefox will" option to "Remember History".

Visit Data
When you start a new transect visit or open a saved transect, the app defaults to this page. If you ever need to navigate back to this page, click on the "Visit Data" button on the left side of the screen.

Observer: Enter the observer's name using the drop down menu. The observer is the person that collected the data. In the event that two surveyors collected data for a single transect in one morning, enter one observer name in the Observer box and the other observer's name in the Observer 2 box. (Required)
Date: Enter the date on which the survey was conducted as yyyy-mm-dd by typing in the appropriate digits. (Required)
GPS Unit #: Enter the four digit number located on the silver property tag of the GPS unit that you used to complete the transect. If you are using a personal GPS unit or a GPS that does not have a silver Bird Conservancy property tag on it, please enter "0000".
Transect ID: Carefully type the Transect ID in the box. (Required)
Observer 2: Refer to the Observer field above
Who Collected?: Select the name of your employer from the drop down menu. (Required)
Data Entry: Enter your first and last name ONLY (i.e. John Smith). Please be sure to enter this even if you were the observer for this transect visit. Make sure you are being consistent with your name (i.e., use the same capitalization scheme and don't enter "Andy" for one survey and "Andrew" for another). The data entry field should be the same for all surveys entered by an individual. Do not include any other info besides your first and last name.
Time: Enter the start and end time of the survey using **24 hour, hhmm format** (e.g. 0545, 1019, etc.). There is no colon and the time must be 4 digits. Enter a zero in the first place holder if the time is between 1 AM and 9 AM. If no time was recorded on the datasheet, enter "0000".
Sky: Enter the sky information recorded at the start and end of the transect. If no sky information was recorded, enter "-1".
Wind: Enter the wind information recorded at the start and end of the transect. If no wind information was recorded, enter "-1".
Temp: Enter the temperature in degrees Fahrenheit recorded at the start and end of the transect. If no temp was recorded, enter "-99".

Notes: Record any notes written in the "Notes" section of the datasheet. Do not use hard returns when typing notes to preserve formatting in our database.

Points Completed

To enter Point Data click on "Points Completed" located on the left side of the screen. Add any necessary rows for individual points on the survey (even if you did not survey that point) by clicking the "Add Point Visit" button at the top of the screen.

Point: Enter the point numbers in numerical order that exist for the associated transect. This will make it easier to proof the data after the field season.

Start Time: Enter the start time for each point from the Bird Datasheet in the format **hhmm** (e.g., 0545) (Note: there is no colon and time must be four digits. Enter a "0" in the first place holder if the time is between 1 AM and 9 AM). If no time was recorded on the datasheet for a given point enter "0000".

GPS Accuracy: Enter the accuracy of the GPS location that was recorded on the Vegetation Datasheet in meters. If no accuracy was recorded on the datasheet enter "-1".

Completed: Select a reason why the point was not completed from the drop down menu if you did not survey the point. This information can be found on the back of the Vegetation Datasheet. By default each point is set as "completed". If the point was not conducted and there is no code recorded on the datasheet for why it was not done enter "O" for other and record "unknown" in the Notes section next to that point.

Notes: This section should be used when you select "Other" as a reason the point was not completed. Explain why the point was not completed in the Notes section.

Vegetation Data

To enter vegetation data, click on the "Vegetation Data" button located on the left side of the screen. After completing the Points Completed Section, you can quickly generate the necessary rows by selecting Edit→Copy rows from points completed. You can also enter rows individually from the Edit menu. Enter all the vegetation information for each point following the directions below.

Data Entry Tip

Be cautious when typing in veg codes that consist of the same letter used twice (e.g. AA: Acacia, BB: Blackberry). When you type the same letter repeatedly, the drop-down list will cycle through codes that begin with that letter alphabetically. For example, when typing in the code for Acacia (AA), if you type the letter "A" once, it will select "AA". If you type the letter "A" twice (which is what you would be more likely to do when trying to get to "AA"), it will select the *second* code that begins with "A" which is AB: Buckthorn. Similarly, to get to CC: Choke Cherry, you will have to type in "C" three times because it is the third veg code that begins with a "C". This is not an issue for codes that consist of two different letters.

Private Property: Check this box for each point that is on private property. Otherwise, leave blank as will likely be the case for refuges.

Primary Habitat: Enter the two letter code or select the code from the drop down list that corresponds to the primary habitat that was recorded. If this field was left blank, or a two letter code was recorded that does not match any of the options in the drop down menu, please select "XX: Not recorded".

Midstory: Check this box if it was checked on the datasheet.

Cliff/Rock: Check this box if it was checked on the datasheet.

P. dog Town: Check this box if it was checked on the datasheet.

P. dogs present?: Check this box if it was checked on the datasheet.

Cheatgrass?: Check this box if it was checked on the datasheet.

Overstory %: Enter the percentage of canopy cover, rounded to the nearest integer. Do not include decimals. If there was no canopy cover present, enter "0". If canopy cover percent was not recorded enter "-1".

Overstory mean height (m): Enter the estimated mean height of the canopy, rounded to the nearest meter. If the observer recorded a height to the first decimal place, round the height to the nearest whole number. Round up if the first decimal place value is 0.5 or higher. If there was no overstory cover present enter "0". If there was no canopy height recorded enter "-1".

# of Snags: Enter the number of snags that were recorded at each point. If there were no snags present enter "0". If the field was left blank on the datasheet enter "-1".

Overstory species and abundance: Enter the two letter code of each species followed by its percentage abundance as a whole number. Leave this section blank if there are no overstory species present. If you recorded a known species that isn't on the list of acceptable two-letter codes, enter "XX" into the database and record the species in the notes section of the visit data tab. If a transect has more than one species recorded as "XX" please enter a note that includes the species and point(s) where it occurred (e.g., overstory species 1 – XX = Western Red Cedar for points 1, 5, 14; overstory species 3 – XX = Western Larch for points 3 and 9). If you recorded an unknown species in the field, enter "OT" into the database.

Shrub cover %: Enter the percentage cover of the shrub layer to the nearest integer. Do not include decimals. If there was no shrub cover present, enter "0". If shrub cover percent was not recorded enter "-1".

Shrub mean height (m): Enter the estimated mean height of the shrub layer, to the nearest 0.25 m (e.g., 0.25, 0.50, 1.50, etc.). If there was no shrub cover present enter "0". If no shrub height was recorded enter "-1".

Shrub species and abundance: Enter the two-letter code of each species followed by its percentage abundance as a whole number. If you recorded a known species that isn't on the list of acceptable two-letter codes, enter "XX" into the database and record the species in the notes section of the visit data tab. If a transect has more than one species recorded as "XX" please enter a note that includes the Species and point(s) where it occurred (e.g. shrub species 1 – point 1 XX=False Azalea; shrub species 2 XX=Snowbrush). If you recorded an unknown species in the field, enter "OT" into the database.

Ground Cover: Enter the percentages to the nearest integer of each ground cover category: Snow; Water; Woody; Dead and Down; Herbaceous; Bare; Litter; Dead Standing Grass; and Live Grass. If data are not recorded for any category enter "-1".

Dead Standing Grass Height and Grass and Herbaceous height (cm): Enter the average height in cm of dead standing grass and live grass and herbaceous in the appropriate columns. If there is no dead standing grass or grass and herbaceous cover present enter "0". If dead standing grass or live grass and herbaceous cover was present and the corresponding height was not recorded, enter -1.

Bird Data

To enter Bird Data click on the "Bird Data" button located left side of the screen. Add blank rows from the Edit button at the top of the screen and select the number of rows you would like to add (1, 10, or 50). Use the tab button to move from left to right through the fields. Note: when

entering "88" bird detections enter the point that **the observer was coming from** in the "Point" column and record the "Minute" as "88".

Data Entry Tip
Be cautious when typing in the point number 11 in the Point field. Because of the way the menu will cycle through the numbers, hitting number 1 twice will navigate to number 10 (as will typing in the number 10). You have to type the number 1 three times to get to 11.

Similarly, take care when typing in bird codes that begin with the same two letters (e.g. CCSP, BBMA). You will have to type in at least the first three letters of the code for the menu to navigate to that code. Just by typing in "BB" or "CC", the menu will go to the second species in the list that begins with that letter.

Point: Select the point number that corresponds to the bird records you are entering. When entering data for an "88" bird detected between points, you will need to associate the data with a point. Select the point you came from as the point number for "88" birds. (Required)
Minute: Enter the minute when the bird was detected (1-6). If the bird was recorded between points, select "88" for minute (and make sure you select the point you came from as the point number). If no minute was recorded for the bird detection enter "-1". Make sure you have entered all of the bird detections for the current point before moving on to the next point.
Species: Enter the four-letter bird code for the bird detection (Appendix B). To quickly find the species you want, while the drop-down list is selected, type the four letter code of the species to automatically select its name. Verify you have selected the correct species, mistakes are commonly made here (e.g., HOWR not HOWA). Press enter or tab to save your entry and move to the next field. When entering "NOBI" records, the data entry system will automatically fill in the Distance, How, Sex, and Cluster Size fields. If the bird code was left blank on the datasheet enter "UNBI". (Required)
Distance: Enter the distance from the observer to the bird in meters (whole numbers only). If no distance was recorded on the datasheet or if the bird was recorded between points, enter "-1". (Required)
How: Enter the code for how the bird was initially detected from the drop down menu. Note: If the bird was detected by any means other than singing or flying over and then was heard singing, there should be a two-letter code to enter (i.e., VS, CS, OS). If the bird was first detected singing, then you should only have one code to enter (S). If a bird is detected flying overhead and is then heard singing, it is not a flyover. Just enter the detection as "S". If the how code was not recorded on the datasheet enter "U". (Required)
Visual: Check this box if the Visual box was checked on the datasheet either by using your mouse or by tabbing to this field and pressing the space bar.
Sex: Enter the sex as it was recorded on the datasheet. If Sex was not recorded on the datasheet enter "U". (Required)
Migrant: Check this box if the Migrant box was checked on the datasheet either by using your mouse or by tabbing to this field and pressing the space bar.
Cluster Count: Enter the number recorded on the datasheet. If Cluster Count was not recorded on the datasheet enter "1". (Required)
Cluster ID: Enter the letter recorded on the datasheet. If Cluster ID was left blank on the datasheet leave this field blank.

Before moving on to the next point, make sure you have entered the same number of birds as are recorded on your datasheet and that the Point, Minute, Species, Distance, How, Visual, Sex,

Migrating, Cluster Size and Cluster Code are all filled in correctly. Verify that you have entered all time periods including NOBIs for minutes without birds.

To quickly delete all blank rows once you are done entering bird data, go to Edit→Remove empty rows.

Hint: Remember to use the tab button to move from one cell to the next.

Saving your entered survey data
You can save your data entry progress by selecting File→Save Transect Visit at the top of the screen. You can save your entered data at any time from any of the data entry pages.
NOTE: You will need to delete any empty rows from the bird data tab before saving.

Editing entered data/Completing a partially entered transect
When you save entered data on your computer, that information is saved within the Firefox browser specifically on your computer. To edit or modify a transect that you have previously entered data for you must open up the index.htm file on the same computer that you entered the data on. Select the appropriate data entry mode and then select the "Saved Transects" button on the left side of the screen. A drop down menu will appear with the dates, transect names, and observer(s) for any transects that you have entered on the computer you are using. Select the transect that you would like to modify. You can make changes just like when you enter data for a new visit. Please remember to save your work.

Uploading entered data to the database
Once you have entered all of the data for a transect and have internet access, you should upload your data to the online database. First, load the saved transect by clicking on the "Saved Transects" button on the left side of the screen. A drop down menu will appear with the dates, transect names, and observer(s) for any transects that you have entered on the computer you are using. Select the transect that you would like to upload and hit OK. Next, hit File→Submit Transect Visit.

You can submit a transect multiple times. In the event that you submit a transect and then realize that you need to make edits to the uploaded data, you can simply edit the transect as described above and re-submit the transect. A warning message will ask if you want to overwrite an existing transect. Be sure you know what you are overwriting before you press "Yes"! NOTE: If you enter data while connected to the internet, it is not necessary for you to save the transect before clicking the "Submit Transect" button. Your data will be saved automatically prior to the submission. You will receive a pop-up message telling you that the data have been successfully uploaded.

If you receive a warning message that the submission failed, relax. The information you entered will have already been saved on your computer and can be recovered at any time by clicking the "Saved Transects" button. If you see an error message when submitting a transect, check all of the tabs to make sure that you've entered all required data. This is the most likely reason that you would receive an error message when submitting a transect. If after checking through your data you are still unable to submit the transect and you cannot figure out the problem, contact your primary contact with Bird Conservancy.

Troubleshooting

You may encounter issues when loading data remotely or submitting data to the database. Look below for commonly made errors, the error message you will receive, and how to correct the error. If you come across an error not listed below, email your primary contact along with the error message and they will instruct you on how to proceed.

Unresponsive Script Pop-up window keeps appearing

Do you frequently see a pop-up window notifying you of "Unresponsive Script"? The next time you see this window pop-up, you want to first check the box saying "Don't ask me again" and then you want to tell it to CONTINUE running the script. This should allow the application to run smoother and you won't be interrupted by the pop-up window anymore.

Unable to load a survey remotely

You may run into a situation where you are unable to load a survey remotely. The most common cause of this issue is that your Firefox browser cache is full. In order to clear the cache, follow these steps:

1. Open up the data entry app in Firefox. Click on the options menu at the upper right side of the screen. Select "Developer", then select Web Console.
2. You will see a small screen at the bottom of the web page with a carrot (>) at the very bottom. Next to that carrot, type "window.localStorage.clear()" and hit enter. Note that the S in Storage is capitalized. This should clear out the localStorage cache in your browser, which is specifically where all the data entry app data is stored.
3. Once you clear out your local storage, close your Firefox browser and reopen the data entry application. You should be able to resume data entry or proofing as usual at this point.

Horribly invalid data

Error Message:

The transect visit submission failed!
Error: FAILED_DESERIALIZE
Text: The submission could not be deserialized (horribly invalid data): **1-** is not a valid value for Int16.

If you received this error, don't panic and don't take it personally. This message simply means that there is a value entered into a field somewhere that the database cannot accept. In this case, the value is "1-". This probably should have been a "-1" instead. Look at the value in the error message that isn't valid, then look for that value entered somewhere in one of the tabs. When you find it, correct it.

If instead of a value, you just see a blank (. . . (horribly invalid data): is not a valid value . . .), this indicates that there is a field left blank somewhere in the data and the database won't allow this. Look for any blank fields that are supposed to have a value, and fill in the value or enter -1.

Once you've corrected the issue, try to resubmit the data. If it still doesn't work, contact your primary contact.

Point doesn't exist
Error Message:

The transect visit submission failed!
Error: POINTVISIT_PARSE_FAILED
Text: The PointVisit could not be parsed because the list of points in the database did not contain the point **17** from the datasheet.

This message indicates you've somehow you entered a point in the Points Completed tab that doesn't actually exist in the database. In this case, someone entered a point 17 on a survey that only contains points 1 – 16. If you receive this message when submitting your data to the database, navigate to the Points Completed tab and check for a point number that may have been entered incorrectly. If there is a survey map included with the data, look at that map to determine which points are legitimate.

If you find the error and correct it in the Points Completed tab, make sure you also correct that error on the Veg and Bird data tabs as well, then resubmit the data.

If you still cannot find the error, email your primary contact with the error message.

Duplicate points
Error Message:

Error: NEWVEG_INSERT_FAILED

Text: The insert into the NewVeg table failed: Violation of UNIQUE KEY constraint 'IX_NewVeg'. Cannot insert duplicate key in object 'dbo.NewVeg'. The duplicate key value is (498830).

This error message indicates that there is a point number duplicated in the vegetation data tab. Navigate to this tab and check through all the point numbers wherever the point numbers are listed. Make sure each of the point numbers is unique and matches the datasheet. Correct any duplicate numbers and resubmit the data to the database. If you are still unable to submit the data to the database, notify your primary contact.

Note: Make sure you check the Points Completed tab if you submit data to the database but never receive a confirmation pop-up window that the data successfully submitted to the database. If this happens to you, check the Points Completed tab and make sure none of the points are duplicated there. If points are duplicated on this tab but not on the Vegetation Data tab, then your data will not submit to the database but you will not receive an error message.

Standard Operating Procedure 4: Data Verification (Full Proof)

Data Verification
The main goal of a full proof is to ensure that the data in the database mirror that on the datasheet and to catch and fix as many data entry errors (e.g., typos) as possible. It is a long and tedious process requiring considerable concentration. Proofers are therefore encouraged to work through the full proof process by dedicating shorter intervals of time each day to the proofing process so they may maintain a sufficient level of focus (and sanity). Following the full proof, refuge personnel will run some proofing queries to catch errors unrelated to typos, such as ground cover percentages not adding up to 100%.

To conduct a full proof, you will need to compare the data on the datasheet with the data entered into the database for every survey you conducted. If the data does not match up, then you will need to correct the data in the database to match the datasheet. In some cases, you may find erroneous or missing data on the actual datasheet. Bird Conservancy staff can also verify a refuge's data if there is a pre-arranged agreement. A refuge biologist should discuss an arrangement with the primary contact ahead of the field season.

Downloading the Data Entry App
App Installation
When your Bird Conservancy primary contact sends you the zipped data entry application folder, right-click on the zipped folder and select "Extract Files" or "Extract All". Set the destination to your Desktop and hit OK. You should now have a folder called "Data Entry" saved on your desktop. Within this folder you'll find the two .html applications that are described in the previous section. **Note: Make sure your Firefox browser is not set to automatically clear browsing history. The data you enter will actually be stored within the browsing history in Firefox, so if you clear your browsing history at any point you will lose any data you've entered but not submitted to the database.**

Updates
The data entry application can go through periodic changes during the field season to improve compatibility for all avian monitoring programs and to increase functionality. The data entry system has been designed to notify users if a new version is available when the program is opened. If, while you are online, you receive a notification (pictured right) that there is a new version of the data entry site available, please follow these steps to update the app:

1. Hit OK.
2. Another window will pop up to reconfirm the update. Hit OK again.
3. A pop-up blocker notification may appear on the top of the screen. Click on the pop-up blocker notification, select "Options", and select "Show http://rmbo.org/v2..."
4. Select "Save File" and Hit OK.
5. Close the Firefox browser containing the data entry application.
6. Extract the new Data Entry files, setting your Desktop as the destination folder.

7. If done correctly, another window will pop up asking if you want to replace the old Data Entry folder with the new one. Select "Yes" every time it asks you if you want to replace a file within the folder (or "Yes to All" if that's an option).

NOTE: The take away message here is to replace the old Data Entry folder with the new Data Entry folder, no matter what you've called it or where it's saved. By saving the latest version to the same location on your computer, your browser will retain links to any saved transects that you have previously entered and you will not lose any data.

Accessing Data

Your primary contact will email the data entry and proofing application in a zipped folder. You will need to download and unzip the data entry folder and use Firefox to open the index.html file within the data entry file. The first time you open the index.html file you will need to be online so that the program can download the necessary files from the database. Upon opening the index file, you will be prompted to select from the following options:

- Data Entry Mode: IMBCR, IMBCR (variable points), Parks, Tamarisk, Habitat, Wintering Grasslands, Restoration Monitoring, Soapstone, Muleshoe, Survival, or NEON.
- Language: English or Spanish
- Species code mode: 4 or 6
- Vegetation code mode: 2 or 6

You will be instructed which modes to use when you receive data to proof, likely IMBCR or IMBCR (variable points). Select the desired modes and then click "Load". This will take you to the data entry home page.

To access data in the database you will need to enter a password. Once the data entry home page has loaded, hold down the Shift key, move your mouse pointer over the Pi (π) symbol in the lower left hand corner of the screen and click on it. A pop-up window will appear asking for a password. Enter the password provided by your primary contact at Bird Conservancy and click on the OK button. If done correctly, you should see the option "Remote Transects" underneath "Saved Transects" in the upper left corner of your screen.

To access the data associated with a transect click on the "Remote Transects" button. A pop up window will appear (right). Carefully enter in the transect name (or copy and paste from your transect assignment list). Once you have entered the desired transect click "load" and then select the appropriate visit (year) and observer from the drop down menu. You should now be able to see the data entered for that transect.
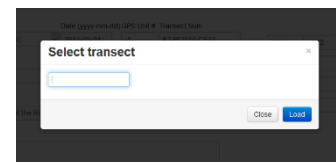
The following sections will give you a detailed breakdown on what to look for while conducting a full proof, how to document errors found in the database, how to handle erroneous or missing data on the datasheet, and how to submit corrected data.

Visit Data

Check the following information to verify that it was entered correctly. Since there is not a lot of information in this section, it will be easier to just look at the Visit Data page and compare the

data in the database to that on the datasheet. Most of the information on this page is recorded at the top of the Vegetation data form. If the transect name on the datasheet is different from what was entered in the database, take care when correcting to ensure there are no duplicate transect names in the database. Contact your primary contact if you are unable to correct a transect name (or any other field) in the database.

Observer
Verify the observer ID on the datasheet matches that in the database.

Date
Verify the date on the datasheet matches the date in the database. Take a minute to confirm that the date and transect name on the bottom of each bird datasheet matches the veg sheet. If the date on the datasheet does not match what has been entered in the database, take care when correcting to ensure there are not duplicate dates entered for separate transects.

GPS Unit #
Verify that the GPS Unit # in the database matches the # on the datasheet. If a personal or non-Bird Conservancy GPS was used, then the GPS Unit # should be "0000".

Observer 2
In some cases two observers will complete a single transect together for safety reasons. One observer name should be listed in the Observer field, and the other observer's name should be listed in the Observer 2 field.

Who Collected
Make sure the survey is associated with the organization that conducted the survey.

Time
Verify that correct start and end times were entered into the database. If no time is recorded on the datasheet then the time should have been entered as "0000".

Sky
Verify the sky codes on the datasheet match those in the database. If no code was recorded on the datasheet the code should have been entered as "-1" in the database. If anything other than a valid code was recorded on the datasheet let your proofing supervisor know. Acceptable Sky codes are (0, 1, 2, 3, 5, 6, and 8).

Wind
Verify the wind codes on the datasheet match those in the database. If no code was recorded on the datasheet the code should have been entered as "-1" in the database. Acceptable Wind codes are 0, 1, 2, 3, and 4.

Temp
Verify the temperatures on the datasheet match the temperatures in the database. If no temperature was recorded on the datasheet then the temperature should have been entered as "-99".

Notes

This section should contain any notes recorded in the "Notes" section at the bottom of each bird datasheet. Check for notes recorded on the datasheets and make sure those notes were entered into the database.

Points Completed

This page contains information about count start times, GPS Accuracy, and reasons points were not completed. Again, since there is not a lot of information in this section, it will be easier to just look at the Visit Data page and compare the data in the data entry application to that on the datasheet.

Point Start Times

Verify the Point Start Times (on the Bird data forms) match the times in the database. If no Point Start Time was recorded then "0000" should have been entered.

GPS Accuracy

Verify the GPS accuracy on the datasheet matches that in the database. If no GPS accuracy was recorded on the datasheet then "-1" should have been entered in the database.

Completed

Verify that each point listed as completed was actually completed. To do this, look at the bird datasheets and find the data for each point listed as completed. You should also verify there are not additional points of data on the hard copy that are not listed as completed in the database. If there are, you will need to change the status of that point to "Completed", enter the start time and accuracy for that point and enter the Veg and Bird data in the corresponding tabs for that point (refer to the data entry protocol for more information on entering data). Lastly, for points that were not completed, verify that the reasons points were not completed entered in the database match the reasons on the datasheet. If the reason is "O = Other" make sure that the notes section contains notes about why the point was not completed.

Vegetation Data

Check the following information to verify that it was entered correctly.

Private Property

Check the Private Property column to make sure the entered data matches the datasheet. Correct any errors in data entry. If the Private Property box on the datasheet has a "Y" on it, then the Private Property box on the data entry application should be checked.

Other (Midstory, Cliff/Rock, P-dog town, P-dogs present, Cheatgrass)

Check to make sure all boxes marked "Y" on the datasheet are checked in the database and all boxes marked "N" are unchecked. If a box was left blank on the datasheet, assume that the field should be populated with an "N".

Primary Habitat

Make sure that all codes entered for Primary Habitat match the codes recorded on the data form. Correct any errors in data entry that you find. If the Primary Habitat field was left blank on the datasheet, leave it blank in the database. If the code recorded does not match any of the options on the drop-down list, make sure "XX" is selected in the database.

% Overstory

Make sure that all data entered for % Overstory match the datasheet. Correct any errors in data entry that you find. If the Overstory % is left blank then enter "-1" to indicate missing data. These records will be reviewed during the query proof process.

Overstory Mean Height

Check to make sure that all entered Mean Canopy Heights match the datasheet. Correct any errors in data entry. If the Overstory Mean Height was left blank, no Overstory Species were recorded, and the % Overstory was entered as "0", enter "0". This indicates that there was no overstory present at this point. If the Overstory Mean Height was left blank and there is information entered in either the Canopy Cover Percentage or the Overstory Species, enter "-1" in the Overstory Mean Height field in the database. This indicates that an overstory was present but the observer forgot to record this information. These records will be corrected in the query proofing process.

# of Snags

Verify the Number of Snags recorded on the datasheet matches the Number of Snags entered into the database. Correct any errors in data entry. If the Number of Snags was left blank enter "-1" in the snags column.

Overstory Species and Abundance

Check all Overstory Species and Percentages to make sure the data entered match the information on the datasheet. Make any necessary corrections. An "XX" code for an Overstory Species indicates that a legitimate two-letter plant code was recorded on the datasheet but that code was not available from the drop-down list at the time of data entry. If the code recorded on the datasheet does not match anything in the drop-down list leave it entered as "XX". This will be corrected during the query proofing process (SOP 5).

If there is a % Canopy Cover or Overstory Mean Height recorded and the Overstory Species field is left blank on the datasheet make sure the Overstory Species fields are left blank and the abundance fields are filled in with "-1" in the database. These records will be corrected during the query proofing process. If there are one or more Overstory Species Percent fields that were left blank enter "-1" in the Percent fields. These records will be revisited during the query proofing process. If there is a percentage recorded with no associated two-letter veg code, make sure the Overstory Species Percentage is entered in the database and enter "XX" for the Overstory Species Code.

% Shrub Cover

Check all values entered for % Shrub Cover and make sure they match the datasheet. Correct any errors in data entry. If the % Shrub Cover is left blank then enter "-1" to indicate missing data. These records will be reviewed during the query proofing process.

Shrub Mean Height

Check all Shrub Mean Heights entered against the datasheet. Correct any errors in data entry. If the Shrub Mean Height was left blank, no Shrub Species were recorded, and the % Shrub Cover was entered as "0", enter "0". This indicates that there was no overstory present at this point. If the Shrub Mean Height was left blank and there is information entered in either the % Shrub Cover or the Shrub Species, enter "-1" in the Shrub Mean Height field in the database. This

indicates that a shrub layer was present but the observer forgot to record this information. These records will be reviewed in the query proof process.

Shrub Species and Abundance

Check all Shrub Species and Shrub Species Percentages to make sure they match the data recorded on the datasheet. Correct any errors in data entry. If "XX" was entered for a species, this indicates that a legitimate two-letter plant code was recorded on the datasheet but that code was not available from the drop-down list at the time of data entry. If the code recorded does not match anything on the drop-down list, leave it entered as "XX". This will be corrected during the query proofing process.

If there is a % Shrub Cover or Shrub Mean Height recorded and the Shrub Species field is left blank on the datasheet make sure the Shrub Species fields are left blank and the abundance fields are filled in with "-1" in the database. These records will be corrected during the query proofing process. If there are one or more Shrub Species Percent fields that were left blank enter "-1" in the Percent fields. These records will be revisited during the query proofing process. If there is a percentage recorded with no associated two-letter veg code, make sure the Shrub Species Percentage is entered in the database and enter "XX" for the Shrub Species Code.

Ground Cover Percentages

Check that all Ground Cover Percentages match the datasheet. Correct any errors in data entry. If any fields in the ground cover section were left blank on the datasheet, enter "-1" in those fields. These records will be corrected during the query proofing process.

Dead Standing Grass Height

Check to make sure that the Dead Standing Grass Height was entered correctly. Make any necessary changes. If the Dead Standing Grass Percent Cover was left blank, "-1" should have been entered for Height. If the Dead Standing Grass Height was left blank and Dead Standing Grass Percent was "0","0" should have been entered. If the Dead Standing Grass Height was left blank or entered as "0" and a non-zero Dead Standing Grass Percent was recorded, enter the Dead Standing Grass Height as "-1" in the database. This indicates that Dead Standing grass was present but the Dead Standing Grass Height was not recorded. These records will be corrected during the query proofing process.

Live Grass and Herbaceous Height

Check to make sure that the Live Grass and Herbaceous Height was entered correctly. Make any necessary changes. If the Live Grass and Herbaceous Percent Cover was left blank, "-1" should have been entered for Height. If the Live Grass and Herbaceous Height was left blank and Live Grass and Herbaceous Percent was "0","0" should have been entered. If the Live Grass and Herbaceous Height was left blank or entered as "0" and a non-zero Live Grass and Herbaceous Percent was recorded, enter the Live Grass and Herbaceous Height as "-1" in the database. This indicates that Live Grass and Herbaceous was present but the Live Grass and Herbaceous Height was not recorded. These records will be corrected during the query proofing process.

Bird Data

Check the following information to verify that it was entered correctly.

Point Number
Make sure the Point Number associated with each bird record matches the datasheet.

Minute
Make sure the Minute associated with each bird record matches the datasheet. If you recorded an "88" bird between points, the datasheet will have the bird with an "88" recorded in the Point column and no Minute recorded in the Minute column. These records should be represented in the database with the Point Number of the previous point and the Minute equal to "88".

If no Minutes were recorded on the datasheet for a Point then each Minute for that Point should be entered as "-1".

Species Codes
Verify that the four-letter Species Codes on the datasheet match the four-letter Species Codes in the database. If the four-letter Species Code on the datasheet does not appear in the database, consult your primary contact at Bird Conservancy and they will let you know what to enter.

Note that for "NOBI" (No Bird) detections the Distance, How, Sex, Visual, Migrating, Cluster Size, and Cluster Code info does not need to be verified. You should check that all "NOBI" detections have a Point and Minute associated with them. Make any necessary corrections to the database.

Distance
Verify the correct distance was entered for each bird record. If no distance was recorded on the datasheet then the distance should be entered in the database as "-1". If a distance over 999 m was recorded on the datasheet, that distance should be entered as "999".

How
Verify the correct How code was entered for each bird record. If no How code was recorded on the datasheet then "U" should be entered. If two How codes were recorded and the second code is anything other than "S", then make sure only the first code recorded was entered. Assume the leftmost How code recorded was the first code.

Sex
Verify the correct Sex code was entered for each bird record. If no Sex code was recorded on the datasheet then "U" should be entered.

Visual?
If the Visual checkbox is checked on the datasheet, make sure that box is checked in the database. **Do not check the visual box in the database if it is not checked on the datasheet no matter what How code was recorded!**

Migrating?
If the Migrating checkbox is checked on the datasheet, make sure that box is checked in the database.

Cluster Size

Verify the Cluster Size on the datasheet matches the Cluster Size in the database. If the Cluster Size is blank on the datasheet, it should be entered as "1" in the database (except for NOBIs).

Cluster Code

If a Cluster Code is recorded on the datasheet make sure the Cluster Code was entered into the database.

"88" Birds

It is easy to make errors with "88" birds. Check to make sure all "88" birds are associated with the correct point (the point you surveyed immediately prior to detecting the "88" bird). If you recorded an "88" bird before the first point or after the last point on a transect remove this entry from the database. You should note these bird detections in the notes section on the Visit Data page (the page where you enter wind, sky, time, etc.).

Submitting Your Changes

Upon completing the full proof of a transect you will need to make sure that any corrections you made are submitted to the database. To do this you will need to click on the "File" button at the top of the page and select the "Submit Transect Visit" option. Please note that clicking "Save Transect" only saves the changes you made on your computer and does not save the changes to the database, so make sure you select the "Submit Transect Visit" option. The first time you do this, it is a good idea to close down the data entry app after submitting, open it again, and pull up the transect you just submitted. Check to make sure the changes you made are still there to confirm you submitted the transect correctly.

Troubleshooting

You may encounter issues when loading data remotely or submitting data to the database. Look below for commonly made errors, the error message you will receive, and how to correct the error. If you come across an error not listed below, email your supervisor along with the error message and they will instruct you on how to proceed.

Unresponsive Script Pop-up window keeps appearing

Do you frequently see a pop-up window notifying you of "Unresponsive Script"? The next time you see this window pop-up, you want to first check the box saying "Don't ask me again" and then you want to tell it to CONTINUE running the script. This should allow the application to run smoother and you won't be interrupted by the pop-up window anymore.

Unable to load a survey remotely

You may run into a situation where you are unable to load a survey remotely. The most common cause of this issue is that your Firefox browser cache is full. In order to clear the cache, follow these steps:

1. Open up the data entry app in Firefox. Click on the options menu at the upper right side of the screen. Select "Developer", then select Web Console.
2. You will see a small screen at the bottom of the web page with a carrot (>) at the very bottom. Next to that carrot, type "window.localStorage.clear()" and hit enter. Note that the S in Storage is capitalized. This should clear out the localStorage cache in your browser, which is specifically where all the data entry app data is stored.

3. Once you clear out your local storage, close your Firefox browser and reopen the data entry application. You should be able to resume data entry or proofing as usual at this point.

Horribly invalid data

Error Message:

The transect visit submission failed!
Error: FAILED_DESERIALIZE
Text: The submission could not be deserialized (horribly invalid data): **1-** is not a valid value for Int16.

If you received this error, don't panic and don't take it personally. This message simply means that there is a value entered into a field somewhere that the database cannot accept. In this case, the value is "1-". This probably should have been a "-1" instead. Look at the value in the error message that isn't valid, then look for that value entered somewhere in one of the tabs. When you find it, correct it.

If instead of a value, you just see a blank (. . .(horribly invalid data): is not a valid value . . .), this indicates that there is a field left blank somewhere in the data and the database won't allow this. Look for any blank fields that are supposed to have a value, and fill in the value or enter -1.

Once you've corrected the issue, try to resubmit the data. If it still doesn't work, contact your primary contact at Bird Conservancy.

Point doesn't exist

Error Message:

The transect visit submission failed!
Error: POINTVISIT_PARSE_FAILED
Text: The PointVisit could not be parsed because the list of points in the database did not contain the point **17** from the datasheet.

This message indicates you've somehow entered a point in the Points Completed tab that doesn't actually exist in the database. In this case, someone entered a point 17 on a survey that only contains points 1 – 16. If you receive this message when submitting your data to the database, navigate to the Points Completed tab and check for a point number that may have been entered incorrectly. If there is a survey map included with the data, look at that map to determine which points are legitimate.

If you find the error and correct it in the Points Completed tab, make sure you also correct that error on the Veg and Bird data tabs as well, then resubmit the data.

If you still cannot find the error, email your primary contact at Bird Conservancy with the error message.

Duplicate points

Error Message:

Error: NEWVEG_INSERT_FAILED

Text: The insert into the NewVeg table failed: Violation of UNIQUE KEY constraint 'IX_NewVeg'. Cannot insert duplicate key in object 'dbo.NewVeg'. The duplicate key value is (498830).

This error message indicates that there is a point number duplicated in the vegetation data tab. Navigate to this tab and check through all the point numbers wherever the point numbers are listed. Make sure each of the point numbers is unique and matches the datasheet. Correct any duplicate numbers and resubmit the data to the database. If you are still unable to submit the data to the database, notify your primary contact.

Note: Make sure you check the Points Completed tab if you submit data to the database but never receive a confirmation pop-up window that the data successfully submitted to the database. If this happens to you, check the Points Completed tab and make sure none of the points are duplicated there. If points are duplicated on this tab but not on the Vegetation Data tab, then your data will not submit to the database but you will not receive an error message.

Standard Operating Procedure 5: Data Verification (Query Proof)

Introduction
To efficiently catch as many errors as possible, the data undergo a full proof (SOP 4) to catch data entry errors followed by a proof using data queries. The proofing queries identify records that are unusual in some way and warrant further inspection. This process forms the second line of defense in eliminating erroneous records that may be missed during the full proof. Do not ignore incomplete or incorrect data that may become evident while following this protocol. If at any point you have concerns about data accuracy, do not wait to address them because you may not remember to correct these issues later. We ask that a primary contact for the refuge oversee the query proofing process. Also, we recommend that all data entry and full proofing be completed prior to the onset of the query proofs. This will ensure that all data are available to be proofed and that full proofers will not undo changes made during the query proofing process. Bird Conservancy staff can also proof a refuge's data if there is a pre-arranged agreement. A refuge biologist should discuss an arrangement with the primary contact ahead of the field season.

You will need to generate several queries in order to complete the data query proofing process. Bird Conservancy has set up a website where you can run queries specific to your study area. This website can be accessed at https://fc.birdconservancy.org/queryproof.aspx. Login information is required to access this website. If you do not have login information, please contact the primary contact, Jennifer Timmer (jennifer.timmer@birdconservancy.org). Once logged in, you will find buttons for proofed or unproofed data, buttons for raw and query proofing data, filter options, and a "Download" button. Query proofers should select "Unproofed Data" and "Query Proofing Data" at the top of the screen. Next, add the "Management Entity" filter and select "US Fish and Wildlife Service". Then, select "Individual Stratum" filter and the refuge you are proofing data for. Lastly, add the "Year" filter and select the current year. The query produces several separate sheets within an Excel file and therefore may take some time to run.

Once you have set your filters, hit the "Download" button to download the queries for your study area. A pop-up window will appear warning you that you are using unproofed data and it will ask you if this is what you want. Click the "OK" button. Once the download is complete a single Excel workbook will be generated with multiple worksheets, one for each query. Save this workbook on your computer for the proofing process. Prior to beginning the query proofing process the proofer should cross-check their list of transects completed with the "Transect Start Times" worksheet in the query proofing workbook to ensure that the query proofing download includes all surveys completed during the desired timeframe. The "Transect Start Times" query should be used since it contains start times for all transects included in the query. Note that the Date column in each tab will have an unusual format. If you highlight the Date column, right-click the selected column and choose "Format Cells", select Date from the options on the Number tab, select the top Date format option, and hit "Okay". The date will be displayed in a standard format (m/dd/yyyy).

The first two tabs in the query workbook contain the raw bird and vegetation data from the query which can serve as a reference tool. The remaining worksheets contain a variety of suspicious records queried from the database. You will investigate the lines within each of these tabs to find and correct typos and look for errors in data collection. In each worksheet the proofer should

change the font color of lines that have been proofed and do not have errors to blue. Similarly, the font should be changed to red for rows with an error. When an error is found the proofer should make a note describing the problem and the change that was made. Once the proofing process is complete, send your saved Excel Workbook with notes to the Bird Conservancy primary contact.

Physical Data

Data Entry
To begin query proofing you will need to have hard copies or scanned copies of all datasheets and all data must be entered into the database and full-proofed. Proofers should visit https://fc.birdconservancy.org/Default.aspx to view a list of surveys entered into the database. Once you have logged in, click on the "Data Entry Status (CSV Download)" option at the top of the page. A data entry status query will automatically run and generate an Excel workbook. This workbook contains a list of transects entered into the database for the current year, the date the survey was conducted, the number of points checked as completed, the number of points with bird data entered (Bird Points), the number of points with vegetation data entered (Veg Points), the difference between the number of bird points and veg points entered, the observer, the name of the person who entered the data, and the date and time the transect was submitted to the database. Check to make sure all of the surveys you or other refuge personnel completed have been entered into the database and verify that you have scans or hard copies of all data forms.

Scanning Datasheets
Electronic copies of bird monitoring datasheets serve as backups in case physical datasheets are lost. Refuge biologists should scan all of their datasheets at the end of each week and save to their computer.

If, for some reason, you do not have a scanned copy of a transect, you will need to create one. Before scanning, compile the datasheets for each transect in the following order: a) vegetation datasheet, b) reasons points not completed data form, c) bird data form(s). Be sure to scan each transect in this order and make sure all pages associated with a transect are saved as a single PDF document.

Verify that all of the scanned data are legible and complete, then save each file with the full transect name, followed by the year the survey was conducted (i.e., "MT-BCR17-CMR1_2018").

You will need to upload your scanned datasheets onto Bird Conservancy's Cloud storage site (https://files.birdconservancy.org). Note: You should always retain a copy of the scanned data on your computer for future reference.

To log in, use the same username and password that you use to access the query website. Please follow the steps below to share your scanned data forms:

> 1. Log on to the site, hit the New button at the top, select Folder, name the folder appropriately and hit enter.
> 2. Click on the folder you just created and hit the upload button next to the New button.
> 3. Navigate to the scanned datasheets you want to upload, click on one of the files, then hit Ctrl+A to select all files

4. Hit the Open button and the files should begin to upload. You should see a progress bar displayed next to the upload button. It will probably take a while for all of the files to upload.

5. Hit the Home button. Hover over the folder you created and click on the Share link to the right. In the space provided, type "matthew mclaren" and hit enter. Click on the "Notify by email" option so that Matthew will know when you've added your files.

6. You're done! Note that after step 1, you can drag-and-drop the datasheet scans into this folder rather than selecting them through the upload option if you prefer.

Datasheet Organization
Compile datasheets for each transect in the order that they were scanned. Organize transects by alphanumeric order according to refuge, BCR, state, or some other logical grouping. File these datasheets into a binder for safe-keeping. You may want to use paperclips to hold the datasheets for each survey together rather than staples until the proofing process is complete. Often corrections are made to the datasheets during the query proofing process and any datasheets that have been corrected will need to be rescanned. Once the datasheets have been scanned for the final time you can staple the datasheets.

Datasheet Check
At the end of the season, check through the hard copies to verify that you have a copy of each completed transect. Check against the list of completed transects you put together during the field season.

Uncommon Bird Proofing
This check should be completed by the refuge biologist to look for possible identification errors made by the biologist or other observers. If a species was recorded infrequently, it could either be because a four-letter species code was recorded or entered into the database incorrectly, the bird was misidentified, or it was identified correctly and is either a rare detection or an infrequently surveyed habitat type. The idea behind looking at uncommon species is to correct any mistakes in the first two scenarios and to confirm rare detections in the third scenario. Data entry errors should have been corrected during the Full Proofing process, so you will mostly be looking for misidentifications and confirming legitimate rare detections.

Determining whether a rare detection is legitimate typically requires input from the person that conducted the survey. Because observers may take some time to respond to your inquiry we suggest that you work on the Uncommon Bird proofing at the onset of the query proofing process.

There are two steps to Uncommon Bird Proofing. The first step is to identify the Uncommon Birds you want to proof and the second step is actually checking each of these uncommon records.

Compiling Bird Data by BCR and Habitat
Open a copy of the query proofing workbook and delete all worksheets except for the first worksheet labeled "Raw Bird Data". Save this workbook as "Uncommon Birds". You will use these raw data to create a pivot table displaying the number of each species recorded. Create two pivot tables, one summarizing the number of individuals of each species by BCR and one summarizing the number of individuals of each species by Primary Habitat (the BCR and Primary Habitat columns are included in the raw bird data query). Separating the data by BCR

and by Primary Habitat will help identify rare detections. For example, the Uncommon Birds by Primary Habitat pivot table might show that one of the 98 WEME detections that occurred in your study area occurred in Spruce-Fir habitat. This record should be investigated. Had you not looked at the data this way, you wouldn't have investigated any of the 98 detections since Western Meadowlarks are generally not considered uncommon.

To create a pivot table by BCR, select all of your raw data, click the "Insert" tab at the top of the Excel document, then select "PivotTable" and hit "Okay". From the Pivot Table Field List on the right, drag and drop "Common Name" into the Row Labels box at the bottom. Next, drag and drop BCR into the Column Labels box (*note: if your refuge lies entirely within one BCR, follow these steps for Primary Habitat instead of BCR*). Then, drag and drop the Cluster Count (CL_Count) in the values box. You should see a table on the left side of the screen summarizing how many individuals of each species were detected in each BCR. At the top of the table you should see "Sum of CL_Count". Right-click on this, select "Summarize Values by" and then select "Count". This will give you the number of detections for each species instead of the number of individuals recorded (that way a cluster of 40 WTSW will show up as 1, not 40). Label this sheet "BCR Pivot".

Copy the BCR Pivot table and paste special "values" into a new worksheet. Delete all unknown species codes (e.g., UNSW [unknown swallow]) and "NOBI" records. Copy and paste this table into a separate worksheet. Repeat this entire process using Primary Habitat instead of BCR to get a list of species by Primary Habitat.

Proofing Uncommon Birds
Go through the list of species by BCR and check that each species recorded makes sense in each BCR. Pay special attention to species detected less than 10 times in a given BCR. Repeat this process looking at each species detected by Primary Habitat to make sure each species makes biological sense for the habitat it was detected in.

When you come across an infrequently detected bird or one that appears out of place for the BCR or habitat, check the datasheet first to make sure the uncommon bird in the database was entered correctly. If the wrong species code was entered, simply change the record to the correct species code. If the species code was entered correctly, you will need to verify that the species recorded could legitimately occur in that area. Use a field guide, Breeding Bird Atlas, eBird, or any other relevant resources to make sure the record is valid. You can also check historic IMBCR data to see if the species has been detected in the same area in the past. Some records will be obviously right or wrong. For those that are wrong, navigate to the Bird Data page for the appropriate survey using the data entry application and make the correction. If you believe a recorded species was misidentified, change the record to "UNBI" in the database (Unknown Bird). You will also need to correct the record on the hard copy of the datasheet in red pen and re-scan it.

You may need to make a judgment call on questionable detections on many of these records, so please do your best to make an informed decision. If you were not the person who conducted the survey, contact the person who did and see if he or she can provide any additional information. Occasionally, observers fail to provide pertinent information regarding these uncommon bird sightings. In these cases you need to decide if the record should be left in the database as is or if the species code should be changed to "UNBI" (Unknown Bird). We recommend erring on the

side of caution and changing bird codes that cannot be determined with certainty to "UNBI". Please keep detailed notes on your actions and remember to change the font to blue or red in the query workbook depending on if the record was confirmed or needed to be changed. Please also be sure to make any necessary changes to the datasheet in red pen and re-scan each hard copy with corrections.

Summarizing detections by BCR and Primary Habitat are just two ways of identifying species recorded in unlikely locations or habitats. If you think of a better way of looking for uncommon birds based on your particular study area, please proceed as you think best.

Queried Data Proofing
The Full Proofing process (SOP 4) is designed to catch errors made during data entry and eliminate typos. However, it does not catch most of the errors that were made during data collection. In order to correct these errors, we run several queries to look for common data collection mistakes. There are four query proofing sections, one for each tab on the data entry application: 1) Visit Data; 2) Points Completed; 3) Vegetation Data; and 4) Bird Data. The final section, 5) Updating Erroneous Data on Hard Copies and rescanning them, will eliminate discrepancies between the database and hard copies/scans to reduce confusion in the future.

You will need to go through the data line-by-line on each worksheet to look for errors in the data as detailed in the following sections. If a line of data is correct change the font color to blue. If a line of data contains an error, change the font color to red and enter notes in the corresponding notes column that describe what was wrong with the data and how it was fixed. To correct the error in the database you will need to remotely load the transect with the error, edit the data and resubmit the data to the database. Proofers should also correct the entry on the datasheet in red pen and re-scan the datasheet.

Note that blank query worksheets mean that no errors were found by that query and you can simply move on to the next query worksheet. Because the data entry application was designed to cut down on the number of errors in the data, you may find quite a few queries with no data.

Transect Info
Transect Start Times
Refer to the worksheet labeled "Transect Start and End Times" in the query workbook. Sort by Transect Start Time (ascending) and check all Transect Start Times that are entered as "0000". If there is a Transect Start Time recorded on the vegetation datasheet then enter the Transect Start Time on the Visit Data page. If the Transect Start Time was not recorded on the vegetation datasheet then enter the Point Start Time recorded on the bird datasheet for the first point count conducted. If no Transect Start Time was recorded on the vegetation datasheet and no Point Start Time was recorded on the bird datasheet for the first point count conducted leave the Transect Start Time as "0000". Next, check all Transect Start Times that are more than ½ hour earlier than sunrise in your study area and check with the observer if someone else completed the survey. Finally, scroll down to check all Transect Start Times more than ½ hour after sunrise in your study area. If you find late start times, check to make sure the data on the datasheet matches that in the database. If your study area covers a large geographical area you may need to look at sunrise times for several locations spanning the study area. For example, the sunrise time for a given date can be quite a bit different in eastern Colorado compared to western Colorado.

Transect End Times

Next, sort the "Transect Start and End Times" worksheet by Transect End Time (ascending). This will display all transects from earliest to latest Transect End Times. Check all Transect End Times that are entered as "0000". If there is a Transect End Time recorded on the vegetation datasheet, enter the Transect End Time in the database. If the Transect End Time was not recorded on the vegetation datasheet then add six minutes to the last Point Count Start Time recorded on the bird datasheet and enter that time into the database. If no Point Start Time was recorded on the bird datasheet for the last point count conducted and the Transect End Time was not recorded on the vegetation datasheet leave the Transect End Time as "0000". Next, sort the sheet by Transect End Time (descending). This will list transects from the latest Transect End Time to earliest Transect End Time. If there are Transect End Times more than 5 hours after sunrise in your area, verify the time was entered correctly. If so, consider removing the data recorded more than 5 hours after sunrise, since this is the cutoff point according to the field protocol. If your study area covers a large geographical area you may need to look at sunrise times for several locations spanning the study area. For example, the sunrise time for a given date can be quite a bit different in eastern Colorado compared to western Colorado.

Transect Start Time Later Than Transect End Time

Refer to the "Start – End > 0" worksheet. Any transects on this list have a Transect Start Time that is later than the Transect End Time. Check the vegetation datasheet to see if the times were entered correctly. If the Transect Start or Transect End Times were entered incorrectly then fix the error. If consulting the vegetation datasheet does not provide you with a reasonable Transect Start or Transect End Time consult the bird datasheets. The first point conducted in the morning should represent the Transect Start Time for the survey. Similarly, if a Transect End Time appears to be incorrectly recorded, add six minutes to the Point Count Start Time for the final point surveyed. This should represent the end of the survey. If you are unable to determine the Transect Start and/or Transect End Times using the vegetation and bird datasheets, then enter "0000" for the missing time.

Point Data
Point Start Time

Refer to the "Empty Point Start Time" worksheet. This query will pull out any Point Start Times entered as "0000". This means a Point Start Time was not recorded for that point on the datasheet. If it is the first point conducted for that survey, see if a Transect Start Time was recorded on the vegetation datasheet. If so, use that as the Point Start Time for the first point. If the Transect Start Time was not recorded leave the Point Start Time as "0000". If it is the last point, see if there is a Transect End Time recorded on the vegetation datasheet. If so, subtract six minutes from the Transect End Time and use that as the Point Start Time for the last point. If the Transect End Time was not recorded leave the Point Start Time as "0000". If a point is missing a Point Start Time, but the point before and the point after have Point Start Times, then determine the midpoint between those two Point Start Times and use that as the Point Start Time. If consecutive points are missing Point Start Times, then leave the Point Start Times as "0000".

Note that if you change a Point Start Time from "0000" to an actual time, the Point Start Time should fall between the Transect Start and End Times found on the vegetation datasheet. If it does not, refer to the following section for how to handle this situation.

Point Start Times outside of Transect Start and End Times

Refer to the "Point Start Not Btw Start & End" worksheet. This query will pull out any Point Start Times that do not fall between the Transect Start and End Times. For each record, check the Point Start Time recorded on the bird datasheet to make sure it was entered correctly. If the Point Start Time was entered correctly but does not fall between the Transect Start and End Times, see if you can determine what the correct Point Start Time should be. If it is the first point conducted, try to determine if the Point Start Time listed on the bird datasheet or Transect Start Time listed on the vegetation datasheet is correct. To determine which time is correct compare the Transect Start Time, the first Point Start Time and the Point Start Time for the next few points conducted. If the Point Start Time is clearly incorrect change it to match the Transect Start Time. For example, if the Transect Start Time was recorded as 0535, the Point Start Time recorded for the first point was 0635 and the Point Start Time for the second point conducted was recorded as 0550, change the Point Start Time for the first point to 0535. If it is clear that the Transect Start Time was recorded incorrectly change it to match the Point Start Time for the first point. For example, if the Transect Start Time was recorded as 0539, the Point Start Time for the first point was recorded as 0528 and the Point Start Time for the second point conducted was recorded as 0542, change the Transect Start Time to 0528. If you cannot determine how to correct the error, change both the Point Start Time for the first point and the Transect Start Time to "0000".

If the Point Start Time for the last point is later than the Transect End Time, compare the Transect End Time and the Point Start Times for the last few points to determine if the Transect End Time or the last Point Start Time should be changed. If the Point Start Time for the last point needs to be changed subtract six minutes from the Transect End Time listed on the vegetation datasheet and use it as the Point Start Time for the last point. If it is clear that the Transect End Time is incorrect add six minutes to the Point Start Time for the last point and record this as the Transect End Time. If you cannot determine if the Transect End Time or the Point Start Time for the last point needs to be changed, change both the Transect End Time and the Point Start Time for the last point to "0000".

If any other Point Start Time falls outside of the Transect Start and End Times for a survey but the points surveyed before and after the point with an incorrect Point Start Time have Point Start Times then determine the midpoint between those two Point Start Times and use that as the Point Start Time for the point with an incorrect Point Start Time. If consecutive points are missing Point Start Times, then leave the Point Start Times as "0000".

Vegetation Data

When proofing the data you may find instances where acceptable values were not recorded and therefore, cannot be entered. In these instances, you will need to mark the appropriate field(s) as unusable in the data entry system. This can be done by putting a checkmark in the Unusable Data checkbox that corresponds to the field within the data entry system.

Important: Any time that you mark a field unusable you need to include comments in the Unusable Notes field located next to "Cheatgrass present?" field in the top right corner of the Vegetation Data tab. Make sure your notes are specific about what data were marked as unusable and why.

You should also include notes regarding the error on the appropriate query proofing worksheet. We recommend that you type your notes on the query proof spreadsheet first and then copy the notes into the Unusable Notes field. It can be difficult to read the notes while typing in the data entry system due to the small field size.

Primary Habitat
Refer to the "Unknown Primary Habitat" query. This query displays all "XX" Primary Habitat codes as well as any blanks. If the Primary Habitat field is "XX" or blank and no notes were written by the observer explaining what the habitat type was, the proofer should review the Overstory, Understory and Ground Cover fields. If the proofer feels confident that they can deduce an appropriate Primary Habitat code for the point, that code should be entered. If it remains unclear what the Primary Habitat type should be after reviewing the Overstory, Understory and Ground Cover data, mark the Primary Habitat field as unusable and add an explanation to the Unusable Notes box for that point.

If you recorded notes on what the "XX" primary habitat stands for, make sure you enter these notes in the notes section on the Visit Data tab and leave "XX" in the Primary Habitat field. If you repeatedly record a specific habitat type not included on the official list of primary habitat codes, please contact Matthew McLaren (matthew.mclaren@birdconservancy.org) to have a new primary habitat classification created.

Invalid Overstory and Snags
Select the "Invalid Overstory and Snags" worksheet. This worksheet will include Overstory data for all Mean Overstory Heights less than 3m and greater than 25m. This worksheet also displays Overstory data for points where a number larger than zero was recorded for Snags and either "0" or "-1" was recorded for Percent Overstory and/or Mean Overstory Height. Check all values on this worksheet for errors with Snags, Percent Overstory and Mean Overstory Height. **Note that there are more proofing instructions dealing with Snags outlined in section H (below).**

Heights less than 3 m: Check all Mean Overstory Heights less than 3 m to make sure they were entered correctly. If the Mean Overstory Height was entered incorrectly and it is actually 3m or more, correct the Mean Overstory Height on the data entry site. If the Mean Overstory Height is equal to 0, check to make sure that no Overstory Cover or Overstory species were recorded. If either of these was recorded, but no Mean Overstory Height was recorded, mark the Mean Overstory Height as unusable and add an explanation to the Unusable Notes box for that point.

If the Mean Overstory Height recorded on the datasheet is <3 m or was not recorded, you'll need to flag at least some of the data as unusable. If species with a height <3 m were recorded in the Overstory this may affect all of the Overstory data, as well as the Understory data since the species should have been recorded in the Understory layer. If you think the observer incorrectly recorded the height and it should have actually been >3 m, then you only need to mark the Overstory Height as unusable and make a note in the Unusable Notes box. However, if you think the observer included plants <3 m in the Overstory, then the Overstory Cover and Overstory percentages are incorrect and should be flagged as unusable and a note added to the Unusable Notes box. In this instance, the Understory Height, Understory Cover and Understory percentages are also incorrect and should be marked as unusable (and a note added to the Unusable Notes box), because the species should have been recorded in the Understory layer.

Heights greater than 25 m: Check all Mean Overstory Heights >25 m. If the Mean Overstory Height was entered correctly and you believe this to be a reasonable height, no action is needed. Mean Overstory Heights >25 m are possible so we do not want to eliminate these data from analyses unless the height for the Overstory species recorded is clearly unrealistic; in which case, you should mark the Mean Overstory Height as unusable and add an explanation to the Unusable Notes box for that point.

Snags with missing Mean Overstory Height and/or Percent Overstory: Check all Snag, Percent Overstory and Mean Overstory Height data on this worksheet. If the datasheet contains data that should have been entered, update the database to match the datasheet. If a value greater than zero was recorded for Snags and no data were recorded for Percent Overstory and/or Mean Overstory Height, mark the Overstory % and Overstory Mean Height data as unusable, add an explanation to the Unusable Notes box for that point, and enter "SN" as an Overstory species with 100% species composition.

Unknown Overstory Codes

Select the "Unknown Overstory Codes" worksheet. This query will display the following two-letter Overstory species codes "XX", "OT", "UC", or "UD". You should consult the raw datasheet for each of these records and enter the appropriate code, provided it occurs in the drop-down list on the data entry site. If "UC" (unknown coniferous species) or "UD" (unknown deciduous species) was recorded on the datasheet, leave the record as "UC" or "UD" in the database. If the code recorded on the datasheet is not a legitimate code and you are unable figure out the intended code, change the code to "OT" (unknown plant) in the database. If the identified plant species is a species which is not currently available to be entered into the database you should proceed in one of two ways: 1) if it is a very rarely observed plant species leave it as "XX" and make a note in the Notes section on the Visit Data tab explaining what the XX stands for; or 2) if it is a more common- occurring species being listed as "XX", contact Matthew McLaren (matthew.mclaren@birdconservancy.org) to have the plant species added to the database and clipboard sheets and, once the species is added, change the record to the appropriate new species code.

Duplicate Overstory Codes

Select the "Duplicate Overstory Codes" worksheet. This worksheet displays data for points where the same species code was recorded at least twice in the Overstory layer. Check these records to see if there was an error in data entry. If a code was entered incorrectly in the database, change the entry in the database to match the datasheet. Confirm that the Overstory percentages still add up to between 90% and 110% (see "Section F Overstory Percentages" below). If the species codes were recorded twice on the datasheet, mark the Overstory species as unusable and add an explanation to the Unusable Notes box for that point.

Missing Overstory Info

Select the "Missing Overstory Info" worksheet. This worksheet includes records where one or two of the following three fields have a non-zero value: Percent Overstory, Mean Overstory Height, and Overstory species. This query will also pull out records that have NULL values for the % Overstory Cover. Check all of these rows in the worksheet against the datasheet. Correct any mistakes you find. If one or more of these fields are blank on the datasheet and something is entered for the remaining field(s), mark the blank field(s) as unusable and add an explanation to the Unusable Notes box for that point. If no vegetation data were collected for the Overstory

portion of the vegetation data then mark % Overstory Cover, Mean Overstory Height, and Overstory species as unusable and add an explanation to the Unusable Notes box for that point.

Overstory Percentages
To check the Overstory percentages, select the "All Overstory by Transect" worksheet. Create a column called "Total Percent" to the right of the last column on the sheet. Add a formula that sums across each row. Sort by "Total Percent" (the rightmost column) from smallest to largest. Check all total percentages that do not add up to 100 to make sure they were entered into the database correctly. Percentages totaling between 90% and 110% are acceptable including 90% and 110%. If the total Overstory percentages on the datasheet add up to less than 90% or more than 110%, flag the Overstory species data as unusable and add an explanation to the Unusable Notes box for that point. If a single value for an Overstory species was not recorded, it is acceptable to fill in a number for that species such that the total Overstory percentage sums to 100%.

Overstory Species
Select the "All Overstory by Transect" worksheet. Create a row at the bottom of the sheet titled "total for each species". Create a formula in the newly created row that sums each column. Using this row, delete any species code that has a value of zero from the spreadsheet. A value of zero indicates that this species was not recorded in the Overstory section. Check to make sure all remaining species codes make sense for the Overstory layer. If the observer recorded a code that seems unreasonable (e.g., an Overstory species that doesn't occur in the study area), first check to make sure the code was entered correctly. If the code was entered correctly but the species doesn't get tall enough to be included in the Overstory layer (and you can't remember what species should have been recorded or the observer does not remember), change the Overstory species code to "OT".

Snags
To check that the Overstory percentages and Snags fields were properly recorded and entered, select the "Snags w No Dead Codes or opposite" worksheet. This worksheet displays transects and points where:

1. A value of "-1" was entered for the number of snags
2. A non-zero value was entered for Snags and BC, BD, DA, DC, DD, DJ, DY or SN was not recorded as an Overstory species; or
3. BC, BD, DA, DC, DD, DJ, DY or SN was recorded as an Overstory species and no snags were recorded in the Snags field.

Note that this worksheet does not display data for points where a non-zero value was entered for Snags and no data was recorded for Mean Overstory Height or Percent Overstory. Those records will appear in the "Invalid Overstory and Snags" worksheet. Sort the "Snags w No Dead Codes or opposite" worksheet by Transectnum then Point and consult the raw datasheet to check all of these records.

For instance # 1 above, check the datasheet and verify the number of snags column was left blank. If not, correct the value in the database. If it was left blank, and the overstory percent is equal to 0, enter 0 for the number of snags. If the overstory percent is greater than zero, mark the

snags column unusable in the database and add an explanation to the Unusable Notes box for that point.

For instance # 2 above, check the datasheet to see if five legitimate Overstory species codes were recorded. If five Overstory species codes were recorded then mark the row on the query worksheet as "okay" and don't make any changes to the database (in other words, the percent cover of snags is less than the smallest percent cover of a living overstory species). If fewer than five Overstory species codes were recorded and the number of Snags is less than the % Overstory Cover (e.g., % Overstory Cover is equal to 20 and 12 snags were recorded) subtract 1% from the largest Overstory species percentage and add "SN" as an Overstory species code with a species composition equal to "1%". If fewer than five Overstory species codes were recorded and the number of Snags is greater than or equal to the % Overstory Cover mark the Overstory %, Overstory Mean Height, and Overstory species data as unusable and add an explanation to the Unusable Notes box for that point. If no Overstory species were recorded and a non-zero value was entered for Snags add "SN" as an Overstory species code and enter "100%" for the Overstory species abundance. You will still need to mark the Overstory % and Overstory Mean Height as unusable in this case and add an explanation to the Unusable Notes box for that point.

For instance # 3 above, check the raw datasheet to verify that no Snags were recorded. If Snags were recorded on the datasheet, but not entered into the database make the appropriate change to the database. If no snags were recorded and one of the dead Overstory species codes was recorded on the datasheet, leave the data as is and do not mark this as unusable. This could be legitimate if the dead trees were less than 6 inches DBH.

Understory (Shrub) Heights
Refer to the "Invalid Shrub Heights" worksheet for sections one and two below. This query will include all shrub heights ≥3 m and <0.25 m.

Heights less than 0.25 m: Check all Understory Heights <0.25 m. If the data were entered correctly and the height recorded on the datasheet is less than 0.25m mark the Understory Height, Understory Cover, Understory species, and Ground Cover data as unusable and add an explanation to the Unusable Notes box for that point. If the Understory Height is equal to "0", check to make sure that no Understory Cover or Understory species were recorded. If either Understory Cover or Understory species were recorded, but no Understory Height was recorded, mark the missing data as unusable and add an explanation to the Unusable Notes box for that point.

Heights greater than or equal to 3 m: Check all Understory Heights ≥3 m. If the data were entered correctly and the Understory Height recorded on the datasheet is ≥3 m, then you'll need to mark at least some of the data as unusable (see next paragraph for details).

Keep in mind if species with a height ≥3 m were recorded in the Understory layer this may affect all of the Understory data recorded, as well as the Overstory data since the species probably should have been recorded in the Overstory layer. If you think the observer incorrectly recorded the height and it should have actually been below 3m, then you only need to mark the Understory Height as unusable and add an explanation to the Unusable Notes box for that point. However, if you think the observer actually included plants ≥3 m in the Understory layer, then the Understory

Percent Cover and Understory species percentages would be wrong and should be flagged as unusable and an explanation added to the Unusable Notes box for that point. The Overstory Height, Overstory Cover and Overstory percentages would also all be incorrect and should be flagged as unusable, because the species should have been recorded in the Overstory layer.

Unknown Understory Codes
Select the "Unknown Shrub Codes" worksheet. This query will display any two-letter Understory species codes that are equal to "XX", "OT", "UC", or "UD". You should consult the raw datasheet and enter the appropriate code provided it occurs in the drop-down list on the data entry site. If the Shrub species code recorded on the datasheet is not a legitimate code and you are unsure about the record, change the code to "OT". If the observer recorded "UC" or "UD" on the datasheet and did not determine the species, leave the record as "UC" or "UD" in the database. If the observer identified the plant species and it is a species which is not currently available to be entered into the database you should proceed in one of two ways: 1) if it is a very rarely observed plant species leave it as "XX" and make a note in the Notes section on the Visit Data tab explaining what the XX stands for; or 2) if it is a more common-occurring species being listed as "XX", contact Matthew McLaren to have the plant species added to the database and clipboard sheets and, once the species is added, change the record to the appropriate new species code.

Duplicate Understory Codes
Select the "Duplicate Shrub Codes" worksheet. This worksheet displays data for points where the same species code was recorded twice in the Understory layer. Check these entries to see if there was an error in data entry. If one of the codes was entered incorrectly, fix the entry in the database. Confirm that the Understory species percentages still add up to between 90% and 110%. If the species code was recorded twice on the datasheet, mark the Understory species as unusable and add an explanation to the Unusable Notes box for that point.

Missing Understory Info
Select the "Missing Shrub Info" worksheet. This worksheet includes records where one or two of the three following fields have a non-zero value: Understory Cover percentage, Mean Understory Height, and Understory species. This tab also will pull out records that have NULL values for the % Understory Cover. Check all rows in the worksheet against the datasheet. Correct any mistakes you find. If one or more of these fields are blank on the datasheet and something is entered for the remaining field(s) mark the blank field(s) as unusable and add an explanation to the Unusable Notes box for that point. If no vegetation data was collected for the Understory portion of the vegetation data then mark % Understory Cover, Mean Understory Height, and Understory species as unusable and add an explanation to the Unusable Notes box for that point.

Understory Percentages
To check the Understory percentages, select the "All Shrubs by Transect" worksheet and create a column called "Total Percent" to the right of the last column on the sheet. Add a formula that sums across each row. Sort by "Total Percent" descending. Check all total percentages that do not equal 100 to make sure they were entered into the database correctly. Percentages totaling between 90% and 110% are considered acceptable including 90% and 110%. If the total percentage adds up to <90% or >110%, flag the Shrub species as unusable and add an explanation to the Unusable Notes box for that point. If a single value for an Understory species

was not recorded, it is acceptable to fill in a number for that species such that the total Understory percentage sums to 100%.

Understory Species
Select the "All Shrubs by Transect" worksheet. Create a row at the bottom of the sheet titled "total for each species". Create a formula in the newly created row that sums each column. Using this row delete any species codes that have a value of zero. A value of zero indicates that this species was not recorded in the Understory layer. Check to make sure all remaining species codes make sense for the Understory layer. If you come across a code that does not make sense, refer to the datasheet to see if it was entered incorrectly. If so, fix the code in the database. If not and someone else completed the survey, email the observer for more information to see if they confused the species for something else or used the wrong code. If you are still unable to fix the code, change the Shrub species to "OT".

Ground Covers that do not sum to 100
Select the "Ground Cover Not 100%" worksheet and Sort by "TransectNum", ascending. The "GroundCover" column displays all total percentages that do not equal "100". Check all rows of this sheet to make sure they were entered into the database correctly. Total percentages between 90% and 110% on the datasheet are considered acceptable and do not need to be flagged as unusable including 90% and 110%. If the database matches the datasheet and the total percentage is <90% or >110% flag the Ground Cover data as unusable and add an explanation to the Unusable Notes box for that point. Note the value "-1" is used to represent data missing from the datasheet. Check these records and update the database if values are actually present on the datasheet. Make sure to double check that the newly entered values add up to between 90% and 110%. If not, mark the Ground Cover data as unusable and add an explanation to the Unusable Notes box for that point. If a single value for a Ground Cover category was not recorded, it is acceptable to fill in a number for that category such that the total Ground Cover percentage sums to 100%.

Grass and Herbaceous Height
Select the "Grass Height" worksheet. This query will display:
- Dead Standing Grass Heights that are "0" when the Dead Standing Grass Cover % is non-zero;
- Live Grass Heights that are "0" when either the Live Grass % or Herbaceous % is non-zero;
- Dead Standing Grass Heights that are non-zero when the Dead Standing Grass % is "0" and;
- Live Grass Heights that are non-zero when both the Live Grass % and Herbaceous % are "0".

If there was Dead Standing grass present and the Dead Standing Grass Height was left blank or recorded as "0", flag the height as unusable and add an explanation to the Unusable Notes box for that point. If there was a Dead Standing Grass Height > "0" recorded, but the Dead Standing Grass % Cover was left blank or recorded as "0", mark the Ground Cover data as unusable and add an explanation to the Unusable Notes box for that point. Repeat this process for Live Grass and Herbaceous Heights. Remember that it is valid to have a Live Grass Height if there is Live Grass OR Herbaceous Cover at a point.

Bird Data
Bird Distances ≤ 0
The "Bird Distances ≤0" worksheet displays all bird records, except for NOBI and "88" bird records, with distances equal to or less than 0. Check all of the records to make sure the data were entered correctly. Make any necessary changes in the database and record notes for any changes you make on the query proof worksheet.

Birds with Cluster IDs
The "Birds with Cluster IDs" worksheet displays all bird records with an alpha code in the Cluster ID field. We need to verify that these are in fact clusters. Check each record to make sure they meet the definition of a cluster. Multiple lines of bird data linked by an alpha code must meet the following requirements:

1. Must be the same species;
2. Must occur on the same point and same minute within a transect;
3. Be within 20 m of one another;
4. Cannot be two singing males.

Look for errors like clusters across species or minutes, a single bird detection missing its partner, or non-alpha codes entered into this column. It's also important to make sure the same cluster code is not reused for different clusters within a single point count. If they are reused, please select a unique cluster code for each cluster and enter it that way in the database. Delete any unnecessary or invalid cluster IDs and record notes for any changes you make, as well as changes in red ink to the original datasheets.

Note: If you have a species and a subspecies paired together as a cluster (e.g. a DEJU and a GHJU), this is fine. When the data go into analyses, the subspecies will be treated as the species and the clustering will be handled correctly.

Unusual Cluster Sizes
The "Unusual Cluster Sizes" worksheet displays all records where the bird code is not "NOBI" and the cluster size is equal to "0". Additionally, records with cluster sizes greater than 5 are displayed in this worksheet. Check all of the records against the datasheet and make any necessary corrections. If you think a cluster size is unrealistic, contact the observer for more information and decide if the value should be kept or not. Also, when reviewing cluster sizes be sure to keep in mind that large clusters may be migrants. Review the survey date, species, habitat, and cluster size to determine if the Migrant box should be checked.

Birds with F, U, or Invalid How Codes
Refer to the "Birds with Invalid How or F U" worksheet. This worksheet displays all bird records with a "How" code entered as "U" or "F".

1. Unknown "U" Code
Check all codes equal to "U" against the physical datasheets to make sure these were entered correctly. If there was no "How" recorded on the datasheet then leave the code in the database as "U". If there is an accepted "How" code recorded, then enter the correct code in the database.

2. Flyovers "F" Code

For all "F" (flyover) detections, it is a good idea to make sure observers understood the definition of a flyover. This is often a difficult concept for observers to understand. Frequently, birds that are flying get recorded as flyovers even if they are actually using the surrounding habitat (e.g., Red Crossbill, swallows, swifts, raptors). If an observer repeatedly records a bird like Red Crossbill as a "flyover" and you believe the bird was using the habitat, you should change the "F" code to "U". We do not include "flyover" birds in analysis, so if an observer consistently recorded a species as a "flyover" when it should not have been, data analyses will be significantly impacted.

Birds with Invalid Minute

The "Birds with Invalid Minute" worksheet will show all bird records where the Minute field is equal to "-1". For bird records where the Minute field is equal to "-1" check the datasheet to see if a valid Minute was recorded and, if so, enter that into the database. If no Minute was recorded and the Minute can be deduced by looking at the bird data (e.g., there is one bird recorded followed by five NOBIs and none of the records have a Minute recorded), enter the Minutes as they should have been recorded. If the Minute associated with the bird record cannot be deduced (e.g., eight bird records on a point with no Minutes recorded), then leave all Minutes equal to "-1".

Incorrect Minute Count

Each point count conducted using the IMBCR design should have six Minutes of data recorded. The "Incorrect Minute Count" worksheet will show the number of Minutes recorded for each point on each survey conducted when the number of Minutes does not equal six. Investigate why these points don't have six Minutes recorded. Some of the errors may have been fixed in the previous query, so be careful not to duplicate your effort here. If errors were made during data entry, make any necessary changes in the database and record notes for any changes you make. If errors were made while collecting the data in the field, there are two ways of handling the problem:

1. No 6th Minute

If an observer recorded Minutes sequentially (e.g., 1, 2, 3, 4, 5), but forgot to record the sixth minute, you can assume that no birds were detected in the last minute. Enter a "NOBI" record for minute six in this case.

2. Too many or too few minutes recorded

If an observer recorded too many Minutes on the physical datasheet, delete bird records associated with Minutes above six. If an observer recorded too few Minutes and they were not recorded sequentially (e.g., 1, 2, 4, 5, 6), then change all of the Minutes for these points to "-1". If the minutes were recorded sequentially starting with 1, you can assume that no birds were detected in the last minutes. Enter a "NOBI" record for each missing minute in this case.

NOBIs with Birds

The "NOBI with Birds" worksheet will display all Transects, Points and Minutes where there are both a NOBI and a non-NOBI bird code. Each of these lines represents an error since these two codes should never be found in the same minute. First check to make sure the data were entered correctly and make the necessary corrections. If the bird datasheet has a valid bird record in the same minute that a "NOBI" entry was recorded, then there are a couple of possible errors made

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in the field. One is the observer wrote down "NOBI" before the minute was over then detected a bird before the minute was over, recorded it, and forgot to delete the "NOBI". The second is the observer forgot to write down a new minute after recording the "NOBI" (or, conversely, the observer recorded a bird and then a "NOBI" without writing in the next minute). We assume the second scenario is more likely and we will proof accordingly. The bird recorded after the "NOBI" (or the "NOBI" after the bird) should be entered as the next minute, and the remaining minutes should be modified to reflect this change. If this results in more than 6 minutes recorded, remove any data from minutes 7 and above from the database.

Migrant Birds
The "Migrant Birds" worksheet will display any bird records that have the "Migrating?" checkbox selected in the database. Review these records and make sure that the "Migrating?" box was actually checked on the datasheet. If the bird record on the datasheet does NOT have the "Migrating?" box checked, please uncheck the "Migrating?" box in the database (unless you determine the bird to be a migrant, see below). If the datasheet does have the "Migrating?" box checked, then review the record (e.g., date of survey, location, habitat, etc.) and determine if the "Migrating" status is reasonable.

If you are uncertain of the "Migrating?", status please contact the observer if someone else completed the survey. Also, remember that the "Migrating?" status indicates that the individual *may* be a migrant. The designation does not indicate certainty. You may want to review all bird species detected within your study area, and the habitats in which they were detected to ensure that detections of likely migrants were recorded as such. It is acceptable to change a detection to a migrant even if it wasn't marked as such in the field if you can confirm that the species does not breed in your study area, but does pass through it during migration. Keep in mind that any detection flagged as a migrant will be removed from analyses, so be sure to verify a species is a migrant through a variety of sources, such as distribution maps, eBird, breeding bird atlases, and local experts before accepting a bird record as a migrant.

Subspecies
The subspecies worksheet will display any species recorded to subspecies where the "Visual" checkbox was not checked. Check the datasheet to see if the Visual checkbox was actually checked, and if so, enter this information into the database. If not, change the subspecies to species in the database.

Updating Erroneous Data on Hard Copies
Before you can finish the query proofing process, you'll need to check through all error tracking sheets from the query proof to find errors that need to be corrected on the hard copies of the datasheet. If bird codes or veg codes were written down incorrectly on the datasheet, these will need to be fixed with red ink to match the database and rescanned. This will prevent future data viewers from trying to "fix" discrepancies that have already been addressed in the proofing process.

Troubleshooting
You may encounter issues when loading data remotely or submitting data to the database. Look below for commonly made errors, the error message you will receive, and how to correct the error. If you come across an error not listed below, email your Bird Conservancy primary contact along with the error message and they will instruct you on how to proceed.

Unresponsive Script Pop-up window keeps appearing

Do you frequently see a pop-up window notifying you of "Unresponsive Script"? The next time you see this window pop-up, you want to first check the box saying "Don't ask me again" and then you want to tell it to CONTINUE running the script. This should allow the application to run smoother and you won't be interrupted by the pop-up window anymore.

Unable to load a survey remotely

You may run into a situation where you are unable to load a survey remotely. The most common cause of this issue is that your Firefox browser cache is full. In order to clear the cache, follow these steps:

1. Open up the data entry app in Firefox. Click on the options menu at the upper right side of the screen. Select "Developer", then select Web Console.
2. You will see a small screen at the bottom of the web page with a carrot (>) at the very bottom. Next to that carrot, type "window.localStorage.clear()" and hit enter. Note that the S in Storage is capitalized. This should clear out the localStorage cache in your browser, which is specifically where all the data entry app data is stored.
3. Once you clear out your local storage, close your Firefox browser and reopen the data entry application. You should be able to resume data entry or proofing as usual at this point.

Horribly invalid data

Error Message:

The transect visit submission failed!
Error: FAILED_DESERIALIZE
Text: The submission could not be deserialized (horribly invalid data): **1-** is not a valid value for Int16.

If you received this error, don't panic and don't take it personally. This message simply means that there is a value entered into a field somewhere that the database cannot accept. In this case, the value is "1-". This probably should have been a "-1" instead. Look at the value in the error message that isn't valid, then look for that value entered somewhere in one of the tabs. When you find it, correct it.

If instead of a value, you just see a blank (. . .(horribly invalid data): is not a valid value . . .), this indicates that there is a field left blank somewhere in the data and the database won't allow this. Look for any blank fields that are supposed to have a value, and fill in the value or enter -1.

Once you've corrected the issue, try to resubmit the data. If it still doesn't work, contact your primary contact at Bird Conservancy.

Point doesn't exist

Error Message:

The transect visit submission failed!
Error: POINTVISIT_PARSE_FAILED
Text: The PointVisit could not be parsed because the list of points in the database did not contain the point **17** from the datasheet.

This message indicates you've somehow you entered a point in the Points Completed tab that doesn't actually exist in the database. In this case, someone entered a point 17 on a survey that only contains points 1 – 16. If you receive this message when submitting your data to the database, navigate to the Points Completed tab and check for a point number that may have been entered incorrectly. If there is a survey map included with the data, look at that map to determine which points are legitimate.

If you find the error and correct it in the Points Completed tab, make sure you also correct that error on the Veg and Bird data tabs as well, then resubmit the data.

If you still cannot find the error, email your primary contact at Bird Conservancy with the error message.

Duplicate points
Error Message:

Error: NEWVEG_INSERT_FAILED

Text: The insert into the NewVeg table failed: Violation of UNIQUE KEY constraint 'IX_NewVeg'. Cannot insert duplicate key in object 'dbo.NewVeg'. The duplicate key value is (498830).

This error message indicates that there is a point number duplicated in the vegetation data tab. Navigate to this tab and check through all the point numbers wherever the point numbers are listed. Make sure each of the point numbers is unique and matches the datasheet. Correct any duplicate numbers and resubmit the data to the database. If you are still unable to submit the data to the database, notify your primary contact at Bird Conservancy.

Note: Make sure you check the Points Completed tab if you submit data to the database but never receive a confirmation pop-up window that the data successfully submitted to the database. If this happens to you, check the Points Completed tab and make sure none of the points are duplicated there. If points are duplicated on this tab but not on the Vegetation Data tab, then your data will not submit to the database but you will not receive an error message.

Standard Operating Procedure 6: Data Analyses

Data analyses will likely be conducted by Bird Conservancy personnel experienced in distance sampling and occupancy modeling to obtain density, occupancy rates, and trend estimates. See below for detailed analysis steps for each estimator. All estimators are calculated for each species within each stratum or individual refuge, and then "rolled-up" to produce regional estimates across participating refuges. By following the IMBCR sampling design and field protocol, participating refuges benefit from pooled detections across the IMBCR program for less-frequently detected species and the ability to compare refuge-specific estimates to the surrounding region (Pavlacky et al. 2017). All analyses are completed using free software available online, mainly program R (R Core Team 2018) and JAGS (Plummer 2003). Bird Conservancy staff could also help train refuge staff to conduct analyses for population estimates or additional analyses, such as bird-habitat relationships and diversity indices. For refuge staff with quantitative skills, the raw data will be available for in-house analysis. Raw data will be available through Bird Conservancy's internal database and also archived on ServCat appropriate R script will also be shared with refuge staff.

Species occupancy
Occupancy allows us to monitor changes in the proportion of sampling units occupied by a species over time (i.e., presence or absence) and accounts for imperfect detectability during estimation (MacKenzie et al. 2002). As such, occupancy serves as an indicator of changes in distribution and allows for explicit estimates of local extinction and colonization rates. For all parameters, when samples are drawn from a larger population of potential samples using a randomized design, inference will be at the scale of the population considered for sampling (Thompson 2002).

The application of occupancy modeling requires multiple surveys of the sample unit in space or time to estimate a detection probability (MacKenzie et al. 2006). The detection probability adjusts the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). Bird Conservancy uses a removal design (MacKenzie et al. 2006) to estimate a detection probability for each species, in which we bin minutes one and two, minutes three and four and minutes five and six to meet the assumption of a monotonic decline in the detection rates through time. After the target species is detected at a point, we set all subsequent sampling intervals at that point to "missing data" (MacKenzie et al. 2006).

The 16 points in each sampling unit serve as spatial replicates for estimating the proportion of points occupied within the sampled sampling units. We use a multi-scale occupancy model to estimate: 1) the probability of detecting a species given presence (p); 2) the proportion of points occupied by a species given presence within sampled sampling units (θ, Theta); and 3) the proportion of sampling units occupied by a species (ψ, Psi).

We truncate the data using only detections <125 m from the sample points. Truncating the data allows us to use bird detections over a consistent plot size and ensure that the points are independent (points were spread 250 m apart), which in turn allows us to estimate Theta (the proportion of points occupied within each sampling unit) (Pavlacky et al. 2012).

We then model occupancy across all species with sufficient data for each refuge using a hierarchical (Nichols et al. 2008, Pavlacky et al. 2012) Bayesian state-space (Royle and Kéry 2007) approach. Occupancy models represent three levels of information: detection probability, point-level occupancy, and grid-level occupancy. Specifically, analyzed data represent a set of values indicating whether or not species are detected at a given point in a given year and a parallel set of values indicating the minute interval when the species is first detected. We model the probability of detecting the species at point k in year t as binomially distributed:

$$y_{kt} \sim Binomial(L_{kt}, p_{bt} \times u_{kt}),$$

where y_{kt} is an indicator of whether the species was detected at point k in year t, L_{kt} is the time period in which the species was first detected, p_{bt} is the probability of detection given occupancy for Bird Conservation Region (BCR) b in year t, and u_{kt} is the latent occupancy state for point k in year t. We model the point occupancy state as Bernoulli distributed:

$$u_{kt} \sim Bernoulli(\theta_{bt} \times z_{jt}),$$

where θ_{bt} is the probability of point occupancy for BCR b, and z_{jt} is the occupancy latent state for transect j containing point k in year t. Detection (p) and point-level occupancy (θ) probabilities for BCRs with ≥ 1 detection of the species come from a hyper distribution where:

$$logit(p_{bt}) \sim Normal(\mu_p, \sigma_p^2),$$

and

$$logit(\theta_{bt}) \sim Normal(\mu_\theta, \sigma_\theta^2).$$

Priors on hyperparameters are vague:

$$logit(\mu_p), logit(\mu_\theta) \sim Uniform(0,1),$$

and

$$\sigma_p, \sigma_\theta \sim Uniform(0,5).$$

This parameterization allows us to share information across BCRs, so it is possible to obtain estimates for strata or refuges with few detections.

Finally, we model latent grid-level occupancy as Bernoulli distributed:

$$z_{jt} \sim Bernoulli(\psi_{jt}),$$

where ψ_{jt} is the grid-level occupancy probability and is modeled as:

$$\psi_{jt} Beta(1,1).$$

Density

We use a zero-inflated *N*-mixture model (Royle et al. 2004, Sillett et al. 2012) to estimate density and abundance for all strata, such as individual refuges, across all species with sufficient data. The true occupancy state of point count location k in grid j, stratum i, and year t is distributed as:

$$z_{ijkt} \sim Bern(\psi_i).$$

The number of independent clusters of individuals, *N*, of a given species at point count location k in grid j, stratum i, and year t come from a Poisson distribution:

$$N_{ijkt} \sim Poisson(\lambda_{ijt} \times z_{ijkt}),$$

with mean λ_{ijt}. Abundances at all points within a grid come from a distribution with the same mean to account for the lack of independence between points.

We estimate stratum-level trends on grid-level mean abundance using a link function:

$$\log(\lambda_{ijt}) = \alpha_i + r_i(t - 1) + \varepsilon_j,$$

where ε_j is a grid-level random effect.

Zero-inflation parameters and random effects come from hyperdistributions:

$$logit(\psi_i) \sim Normal(\mu_{\psi_i}, \sigma_\psi^2),$$

and

$$\boldsymbol{\varepsilon} \sim Normal(0, \sigma_\varepsilon^2),$$

where μ_{ψ_i} is the proportion of grids on which the species was detected. We are required to constrain the hyperdistribution on ψ in this way so as to not overestimate abundance in strata with few detections. Likewise, for strata in which the species is never detected, we fix $\psi_i = 0$. This parameterization allows us to estimate density with uncertainty even when the species is not detected in a stratum or refuge, such as with low-density species.

We derive density, *D*, at the point count location as:

$$D_{ijkt} = \frac{N_{ijkt} \times s}{A_c},$$

where A_c is the area of the point count circle and s is the cluster size. We derive stratum-level density estimates by averaging all point-level density estimates within each stratum, and we take the area-weighted average of strata estimates to obtain regional estimates across all participating refuges.

We estimate the probability of detecting an independent cluster of individuals by fitting distance functions to the distance data collected during surveys (Buckland et al. 2001). We fit 4 detection models including: 1) half-normal constant (HN(.)), 2) hazard rate constant (Haz(.)), 3) half-normal year (HN(t)), and 4) hazard rate year (Haz(t)), and choose the most parsimonious detection function structure using Watanabe-Akaike Information Criterion (WAIC; Watanabe 2010, Hooten and Hobbs 2015).

We model the number of detections in each distance class at each point count location in year t as:

$$y_{ijkt} \sim Binomial(p_t, N_{ijkt}),$$

where p_t is the overall detection probability based on the chosen detection function.

Population trend

For refuges or strata with ≥ 2 years of data, we estimate trends by calculating the least-squares (LS) regression mean and standard errors for the intercept and slope of the log densities across time. We calculate these parameters for every iteration of the MCMC algorithm to account for uncertainty around density estimates. However, this does not capture the uncertainty in regional trends across participating refuges due to annual variation. Therefore, we choose a random intercept and slope within each iteration using the LS estimates:

$$\tilde{\alpha}_s \sim Normal(\mu_{\alpha_{LS}}, SE_{\alpha_{LS}}),$$

and

$$\tilde{r}_s \sim Normal(\mu_{r_{LS}}, SE_{r_{LS}}),$$

to reflect both sources of uncertainty around our region-level trends.

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