U.S. Fish and Wildlife Service
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National Wildlife Refuge System

National Protocol Framework for the Inventory and Monitoring of Breeding Landbirds Using Point Counts

Version 2.0 **February 2016**

ON THE COVER
Yellow Warbler (*Setophaga petechia*), Photograph by: Patricia Heglund

NWRS Survey Protocol Signature Page

Protocol Title: National Protocol Framework for the Inventory and Monitoring of Breeding Landbirds Using Point Counts **Version[1] :2.0**	
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Version[1]	Year	Author	Change Made	Reason for Change
1.0	2008	Knutson et al.	N/A	N/A
2.0	2016	Knutson et al.	Reformatted; updated data management section/SOP; added veg-type classification SOP	Policy 701 FW2 and use of new procedures for data management, sampling site classification.

[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 survey protocol framework.
[3] Signature signifies approval of a survey protocol framework.
[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 a standardized tool for monitoring breeding landbirds in North America by use of point counts. The protocol is suitable for use in forests, shrublands, and grasslands and supports estimates of bird species abundance, occupancy, and detection probabilities. The bird observation and recording methods described here accommodate the use of the time-removal method for estimating detection probabilities (Farnsworth et al. 2002; Alldredge et al. 2007a). All FWS Regions and partners are encouraged to use this framework to monitor breeding landbirds when their management objectives and information needs are compatible with the protocol.

Version 2.0 updates the original protocol, *Landbird Monitoring Protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions – Version 1.0* (Knutson et al. 2008). Revision was prompted by the transfer of landbird data from the USGS Patuxent Wildlife Research Center to the Avian Knowledge Network (AKN) in 2014 and the need to revise the data management instructions and the field data sheet to match the new database. Modifications from Version 1.0 include: a) renaming to reflect status as a national protocol framework, not limited to any region; b) reformatting of the entire protocol to meet the standard set in the U.S. Fish and Wildlife Service's *How to Develop Survey Protocols: a Handbook* (U.S. Fish and Wildlife Service 2013); c) updating methods for documenting mapped vegetation classes associated with the bird counts, d) updating methods for data entry; and e) general technical editing. *The bird point count methodology is unchanged from Version 1.0, aside from technical editing and formatting to conform to the Survey Protocol Handbook.* Some details in the original protocol regarding rationale for the selected bird count methods have been moved to Supplemental Material (SM 1). Methods that support estimation of detection probabilities are now accepted practice; in 2008 such methods were considered unnecessary by many ornithologists.

The protocol framework addresses eight elements, including a protocol introduction, sampling design, field methods, data management, analysis, reporting, personnel requirements and training, operational requirements, and references. Additionally, a series of standard operating procedures provides greater detail on recommended methods and technical aspects of this protocol. Data entry, archival, and multi-scale analysis are handled through an online database that is part of the AKN.

Suggested citation:
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This protocol is available from ServCat: [https://ecos.fws.gov/ServCat/Reference/Profile/54162]

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The following persons contributed to Version 1.0 of the protocol (Knutson et al. 2008):

- Authors not contributing to Version 2: Nick Danz, Brian Gray
- Review Team: Karen Westphall, Gary Pogue, Dorie Stolley, Holly Gaboriault, Tom Will, and Randy Dettmers. Brian Mitchell, Bill Route, Paul Geissler, Sam Droege, C.J. Ralph, John Sauer, Doug Johnson, and Frank Rivera-Milan provided reviews.

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Narratives

Element 1: Introduction

Background

This protocol framework is a standardized tool for monitoring breeding landbirds in North America by use of point counts. The protocol is suitable for use in forests, shrublands, and grasslands and supports estimates of bird species abundance, occupancy, and detection probabilities. The bird observation and recording methods described here accommodate the use of the time-removal method for estimating detection probabilities (Farnsworth et al. 2002; Alldredge et al. 2007a).

The Partners in Flight *North American Landbird Conservation Plan* provides a list of bird species that are considered landbirds (Rich et al. 2004). Point counts are especially appropriate in shrublands or forests and any places where obstacles make it difficult to focus on bird detections while traversing the terrain. This protocol was not designed to monitor waterbirds, secretive marsh birds, or landbirds during winter or migration. For some groups of landbirds (raptors), alternative monitoring methods may be more effective, depending upon sampling objectives (Kirk and Hyslop 1998). Standardized methods are available to monitor nonbreeding waterbirds (Loges et al. 2015) and breeding secretive marsh birds (Conway 2011, 2015). During other seasons, alternative methods may be more useful for surveying landbirds (Gauthreaux et al. 2003; Rodewald and Brittingham 2004; Atchison and Rodewald 2006).

The protocol framework is most likely to be used at National Wildlife Refuge System (NWRS) stations or groups of cooperating stations to answer questions relevant at a local scale. At this time there is no clear need for a broad scale (national or regional) point count sampling design to document general status and trends monitoring of breeding landbirds. The North American Breeding Bird Survey serves the purpose of a broad-scaled surveillance system for temporal trends and spatial distribution of landbirds. Therefore, we provide examples of objectives and sampling designs suitable for addressing management objectives or questions about bird associations with environmental variables.

The protocol framework is designed to comprise the main body of a site-specific survey protocol (SSP) (U.S. Fish and Wildlife Service 2013). The SSP will contain all the guidance from the protocol framework and additional details needed to conduct the survey at specific locations, including everything new staff would need to continue or repeat the survey, and analyze and interpret survey results. The SSP is analogous to a detailed study plan for a research project but even more critical to the success of the monitoring project (survey). Staff turnover in leadership roles is rare in research projects but common in surveys led by management agencies; good documentation is essential to the success of a survey. Content in the SSP includes documenting the purpose of conducting the survey at that location, the sampling design employed, maps of sample locations, logistical instructions, lists of potential bird species, and lists of ecological systems associated with the sample points. See the *Survey Protocol Handbook* for more guidance on how to develop a SSP (U.S. Fish and Wildlife Service 2013). Lists of birds in the SSP should follow the current edition of the American Ornithologists' Union (AOU) *Checklist of North American Birds* and annual supplements, available for download from the AOU website.

Version 2.0 updates the original protocol, *Landbird Monitoring Protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions – Version 1.0* (Knutson et al. 2008) (SM 1). Revision was prompted by the transfer of landbird data from the USGS Patuxent Wildlife Research Center to the Avian Knowledge Network (AKN) in 2014 and the need to revise the data management instructions and the field data sheet to match the new database. Modifications from Version 1.0 include: a) renaming to reflect status as a national protocol framework; b) reformatting of the entire protocol to meet the standard set in the U.S. Fish and Wildlife Service's *How to Develop Survey Protocols: a Handbook* (U.S. Fish and Wildlife Service 2013); c) updating methods for documenting mapped vegetation classes associated with the bird counts (SOP 4), d) updating methods for data entry; and e) general technical editing. *The bird point count methodology is unchanged from Version 1.0, aside from technical editing and formatting to conform to the Survey Protocol Handbook.* Details presented in the original protocol regarding rationale for the selected bird count methods have been moved to Supplemental Material (SM 1).

Objectives

Clear objectives are the foundation upon which a monitoring program is built. Objectives are critical to the success of surveys, but are often missing (Johnson 2000; Lindenmayer and Likens 2010). Once the management objective is clear, the sampling design follows. Examples of management and sampling objectives that can be addressed with this protocol are given below. Sampling designs for common objectives and logistic constraints are presented in SOP 1.

Begin with the end in mind. Planning for a new survey should begin well in advance of the first field season; we recommend at least six months. Thinking through the entire monitoring process in a rapid prototyping manner *before* collecting any data, and consulting appropriate experts in sampling design, data analysis, and data management, is strongly advised (Reynolds 2012; Reynolds et al. in review). Careful thought and planning in the beginning can save years of wasted time and effort conducting monitoring that fails to inform management (Reynolds 2012).

It is not too early to think about how you want to summarize your future monitoring data. What types of tables, graphs, or charts do you want; what type of analysis will you apply to the data; and when will they need to be delivered in order to inform the next management cycle? Do you simply want a list of species occupying your station; do you want to know if the entire bird community has changed as a result of management, or are you mainly interested in 2-3 key species? If you know how you will analyze the data and produce your summary information, the sampling design follows.

The sampling design will be developed by the survey coordinator to meet the specific objectives of the survey and will be defined in the SSP. We provide guidance for the selection of sample points via several different sampling designs (SOP 1) that address specific management objectives, all of which employ estimates of bird abundance and occupancy. A word of caution regarding monitoring of bird populations: birds respond to stressors, threats, and multiple causes of mortality over their entire life cycle (Stahl and Oli 2006). For migratory species, only a small proportion of a bird's life cycle may be associated with any specific management units. Therefore, changes in bird populations or occupancy at any single site may be due to factors (diseases, predators, hazards) other than those operating at the site of interest.

Examples of management objectives and associated sampling objectives are given below. These objectives can be used as guides; stations should specify their management and sampling objectives in the SSP based on this framework (U.S. Fish and Wildlife Service 2013). Guidance on defining management and sampling objectives is available from several sources (Elzinga et al. 2001; Adamcik et al. 2004; Paveglio and Taylor 2012). Sampling design is a specialized field within statistics; consultation with a statistician during the design phase of a survey is recommended (Reynolds 2012).

Inventory—This protocol is suitable for conducting an inventory of landbird species, estimating their abundance, density, or occupancy. The objective is to estimate the status of all landbird species in the target habitat. This objective is generally applicable when there are no baseline data for the site. For this objective, sample the largest number of points in the target habitat that you can, regardless of the size of the land unit. If the unit will only accommodate 10 points, sample them all. For larger land units, the more points sampled, the higher the probability of detecting a large proportion of the species present. Example:

- Management objective: Create a species list for the station or management unit Z and estimate the abundance (birds/point), density (birds/ha), or the occupancy (proportion of sites occupied) for a set of landbird species in the years 2015–2016. Use pilot data to estimate the sample sizes needed to meet future management objectives (see below).

- Sampling objective: 80% confidence that the abundance/density/ occupancy estimates for species present are within 20% of their respective true values (mean ± 20%).

Estimate Change Over Time—Detect change in abundance, density, or occupancy of landbird species. For this objective, monitoring may be conducted over long time periods (5–10 years). Example:

- Management objective: Detect a 50% decrease in the abundance (birds/point), density (birds/ha), or occupancy (proportion of sites occupied) of species X from 2015 to 2025 on management unit Z.

- Sampling objective: 80% confidence (α=β=20%, one-tailed test) in detecting a 50% decrease in the abundance/density/occupancy of species X from 2015 to 2025, with a 20% chance of inferring a decrease when one does not exist.

Community Composition—Detect change in community composition of landbird species. Example:

- Management objective: Detect a 20% decrease in the species richness of landbird species from 2015 to 2020 on management unit Z.

- Sampling objective: 80% confidence (α=β=20%, one-tailed test) in detecting a 20% decrease in species richness of landbird species from 2015 to 2020, with a 20% chance of inferring a decrease when one does not exist.

Effectiveness Monitoring—The protocol can be used to evaluate achievement of a species objective in abundance, density, or occupancy, usually in response to management actions. Or, the protocol can be used to detect a threshold level of abundance, density, or occupancy, usually as a signal to employ management. Example:

- Management objective: Through management actions, increase species X to an abundance of 0.4 birds/point or the probability of occupancy to 40% from 2015 to 2020 on management unit Z.

- Sampling objective: 80% confidence that the abundance and/or occupancy threshold has been achieved (1-tail, t-test comparing mean with target or threshold) within 20% of true values (mean ± 20%).

Adaptive Management—If the monitoring is undertaken primarily to inform future management decisions or actions, an adaptive management framework may be needed to place the monitoring in its proper context; the framework will ensure that the monitoring information informs management decisions (Nichols and Williams 2006; Knutson et al. 2015).

Monitor bird abundance, density, or occupancy as part of an adaptive management process. This objective is used only if a specific management action or decision is framed as part of an adaptive management process (Williams 2011). Adaptive management is a systematic approach for improving resource management by learning from management outcomes (Williams et al. 2009). Adaptive management requires five elements: objectives, potential management actions, models of system response to management actions, measures of confidence in the models, and a monitoring program that assesses achievement of objectives and updates the models (Nichols and Williams 2006). Over time, the resource manager learns which management actions have the highest probability of achieving the stated objectives, given key system variables. Example:

- Management objective: Estimate the abundance (birds/point), density (birds/ha), or the occupancy of a set of landbird species in 2015 on management unit Z after applying management action H. The monitoring data (actual outcomes) will be used to update confidence measures for a set of competing models that predict bird community responses to specific management actions or decisions. These confidence measures will help the manager select among alternative management actions in the future.

- Sampling objective: 80% confidence that the abundance/density/ occupancy estimates are within 20% of the true value as a starting point (mean ± 20%); the estimates need only be accurate or precise enough to distinguish among competing predictive models. If more accuracy or precision is needed to distinguish among the models than can reasonably be obtained, then reconsider using these metrics and explore other monitoring metrics that will have the needed accuracy and precision. Another alternative is to re-define the competing models.

Habitat Associations—The protocol can be used to explore habitat associations or other factors that may contribute to changes in abundance, density, or the probability that a site is occupied by a species. This objective requires hypotheses about relationships between environmental factors and the bird community followed by data collection focused on specific environmental factors and bird point counts. A protocol for collecting the environmental variables will be needed; habitat monitoring, other than assigning the appropriate broad ecological system class to each point, is not included in this protocol framework. Example:

- Management objective: Assess bird species habitat relationships in shrub-dominated sites in X ecoregion.

- Sampling objective: Identify the best-fitting models that explain variation in abundance, density, or occupancy in shrub-dominated management units.

Element 2: Sampling Design

Sample units and sampling frame

Important issues to consider in a monitoring plan are the target population and the sampling frame (Reynolds 2012). The target population is what you are interested in learning about (which landbird birds inhabit my station or management unit Z?). The sampling frame is that population of sampling units (typically locations) that most closely approximates the target population and that has some possibility of being sampled (entire station, management unit Z, all grassland habitats on the station, etc.). All SSP should clearly define the target population in the objectives and define the sampling frame in the sampling design (SOP 1) so that it is clear to which area or population the summary information applies (inference). For example, this protocol is designed to monitor the entire community of breeding landbird species in the study area or a selected subset of that community. If your objective is to survey only a subset of bird species rather than the entire community, document that in the SSP; that decision will affect the analyses you can conduct.

A fundamental rule of sampling design is that you can’t extrapolate your results to locations or portions of the population that had no opportunity to be sampled. For example, perhaps large areas of your target area are inaccessible due to the presence of unexploded ordnance (military weapons). You might be very interested in the birds that breed in those locations (target population), but if those areas are not in the sampling frame (no possibility of being sampled), then you can’t attribute your results to those areas. You should be able to describe your sampling frame and create a map, blocking out any areas that were not in the sampling frame. It is rare that your sampling frame will encompass your entire population of interest; your sampling design is the best representation of the population of interest that you can achieve, given logistical and resource limitations. Specific examples and recommendations regarding sample frames and site selection, given common logistic constraints, are provided in SOP 1. The more complex your sampling design, the more you will need technical assistance from a statistician regarding the appropriate analyses needed to generate summary statistics. General guidance for small projects with limited resources is to keep the sampling design as simple as possible so that common statistical methods can be employed.

Sample selection and size

The sample size for detecting temporal trends depends upon the management objectives, the desired minimum detectable trend, and the time frame. That is, how much change is meaningful from a management perspective and over what time period? Statistical consultation is advised; the following examples illustrate the complexity of this issue and provide only general guidance. Complex designs generally require simulations to estimate sample sizes and effort (Gray and Burlew 2007; Thogmartin et al. 2007; Reynolds et al. 2011; Reynolds 2012).

Detecting declining trends in abundance is difficult with a small data set or over a short time period. Over short time frames, only catastrophic trends (-5%/yr.) are likely to be detected, even for common species (Thogmartin et al. 2007). In a study of landbirds in California, Purcell et al (2005) found that with 210 point-count stations, visited four times each year, they were not able to detect a 30% decreasing trend in species abundance after 20 years (-1.8% annual decline) for 44% of breeding species. *To estimate trends in a project with similar effort, they recommended data collection for a minimum of 15-20 years if stations are visited less than six times a year*.

Thogmartin et al. (2007) investigated sample sizes to estimate trends using bird data from floodplain forests of the lower Missouri River. They found that >50 sites, if sampled annually over three years, would typically provide warning for common species exhibiting 10%, 5%, and sometimes 3% annual declines (88, 64, and 50% declines, respectively, over 20 years). Using a different approach, Thompson and Reidy (2009) summarized landbird point count data from national wildlife refuges in the Northeast. They estimated relative error (half the width of the 95% confidence interval expressed as a percent of the abundance estimate) and found it acceptable (± 60%) when the number of detections for a bird species per year was ~25. *Therefore, if a species has fewer than 25 detections per year, trend estimates are likely not feasible.*

To apply the above information heuristically, if the objective is to detect catastrophic abundance declines (5-10% annual or 64-88% over 20 years) in relatively common bird species over short time frames (<10 years), at least 50 sample sites will be required. To detect large abundance declines (3-5% annual; 50-64% over 20 years) in less common or rare species, many more sites (100-200), perhaps sampled repeatedly within a season, and over longer time frames (10-20 years) will be needed. A perhaps simpler approach is to conduct a pilot study; if the pilot study finds that 5 species had 25 or more detections per year; it is likely that a long-term monitoring effort (15 or more years) with similar effort (number of sites, visits per year) would yield useful trends for these species.

Small land management units seeking to estimate meaningful trends in landbird abundance will likely need to collaborate in a larger project over at least 15 years. Pilot data or simulations will be needed to determine more specifically the required sample sizes from estimates of sampling variation and criteria defined in the sampling objective. Monitoring rare species or those difficult to detect may require alternative methods. In a nutshell, a survey may not yield useful trend information if small sample sizes and inadequate resources (funding, staffing) over the recommended time frames are anticipated.

Many management objectives will not require trend estimates. For example, if a manager is focused on detecting a threshold of abundance or occupancy before initiating a management action, trend estimation is not needed, only some level of precision in estimating bird abundance or occupancy and perhaps another environmental attribute.

Sources of error

The major errors common to bird monitoring include: not detecting a bird when it is present (Alldredge et al. 2007c), misidentification of the species, and sampling outside of the breeding season. Bird observations via point counts are assigned to a distance band relative to the observer. Assignment of individual birds to the correct distance band is subjective, despite the use of a range-finder. Other errors include recording errors in the field and during data entry into the online database. The assumptions associated with monitoring breeding landbirds include assuming that a bird is observable and remains within its breeding territory during the observation period. Conducting counts outside of the breeding season can result in detection of birds that have moved from their breeding territories, which may lead to miscounting of residents or inclusion of migrating individuals.

Many factors can influence the number of birds observed during a point count survey. These factors include wind, rain, noise levels, time of day, observer differences, and spatial heterogeneity (Simons et al. 2007). While the point count protocol has features built-in to minimize many of these sources of variability, their potential influence should be incorporated into the analysis and investigated explicitly. Of particular importance may be variability associated with different observers (Ramsey and Scott 1981). There are well-developed statistical methods that account for observer variability when individual observers complete surveys in multiple years (Sauer et al. 1994; MacKenzie et al. 2002), however, dealing with observer variability is more difficult when observers survey in only one year (Thompson et al. 1998).

Proper training, including periodic feedback, of observers and data entry personnel, along with early review of the data is paramount for minimizing errors (see Element 6). The AKN database is designed to minimize errors through the use of pull-down menus, flagging out-of-range species, and limiting entries to defined lists or selected ranges of numbers. Built-in reporting tables and graphs also help identify out-of-range species and other outliers.

Estimating Population Size— The ultimate objective of a population monitoring program is to make conclusions about the magnitude and direction of change in true population size through time. The point count is a method for surveying rather than completely enumerating all birds in an area (i.e. censusing), thus, the raw number of observations recorded during a point count is not a measure of density. For trend analysis, if the raw counts of birds are a constant proportion of true population size, it may be possible to use unadjusted counts as an index of the population. However, if the chance of observing a bird is not constant through time or between habitats -- that is, if there is heterogeneity in the detection probability -- then the raw counts will not be an unbiased index of population size.

There is a growing body of literature that indicates raw counts of individual birds are not an accurate index of the population and need to be adjusted for detection probability (Nichols and

Conroy 1996; Pollock et al. 2002; Simons et al. 2007), but see Johnson (2008). Several alternative methods for evaluating and incorporating detection probabilities into the analysis are available. These include distance estimation (Buckland et al. 1993; Buckland et al. 2001), conducting multiple visits within a season (MacKenzie and Royle 2005), and counts by two observers visiting a point simultaneously (Nichols et al. 2000; Alldredge et al. 2006; Alldredge et al. 2008). However, each method has limitations or assumptions that deter land managers from using them in multi-species monitoring programs (Johnson 2008). For example, training requirements for double observer counts can be daunting. Multiple visits and double observer methods require more staff than single visits by a lone observer.

Estimating Detection Probability—The field sampling method employed in this protocol, described in detail in SOP-3, supports estimates of detection probability using time-removal methods (Farnsworth et al. 2002; Farnsworth et al. 2005; Alldredge et al. 2007a; Alldredge et al. 2007b) and distance methods (Buckland et al. 1993), although the distance analysis is limited by pooling observations into distance bands. The time removal method supports the application of capture-recapture models by using time intervals in place of multiple visits (Alldredge et al. 2007a).

Observers record the one-minute time period associated with the *first* observation of a bird. This is relatively simple to record and provides flexibility to the data analyst to group times together in an optimal way, depending upon objectives. Field testing indicated that it was not practical to record both the one-minute intervals and exact distances; recording minutes was simpler and more accurate than recording exact distances to birds, especially in habitats where the majority of birds are heard and not seen (Alldredge et al. 2008).

Observers will visit each survey point a minimum of one time within the breeding season. However, multiple visits will open the possibility of additional occupancy analysis modeling tools (MacKenzie et al. 2006) and provide an alternative way to estimate detection probabilities. If the sampling frame is small, repeat visits will help increase the species list and increase your power to detect change.

Element 3: Field Methods and Processing of Collected Materials

Pre-survey logistics and preparation

Planning for a survey should begin at least six months prior to field work. A survey coordinator will be assigned to lead, oversee, and coordinate all aspects of the survey. Multi-station or multi-agency surveys will need a survey project coordinator to lead the project and a survey coordinator at each station conducting the survey. The project coordinator manages the whole survey and the station survey coordinator manages activities at each station. A station is considered a single office; multiple stations may comprise a refuge complex, or offices from different agencies or organizations. The project or survey coordinator will need to write a SSP for each office in the survey. This can take a month or longer, if combined with other routine duties. Multiple stations collaborating on a joint survey can use the same SSP, changing mainly the maps and survey locations.

A few months before the surveys begin, the coordinators and crew leaders for the bird surveys will review the SSP. Several weeks may be needed for crew leaders to prepare for the training session and organize field gear, especially in the first year of a new monitoring effort.

The survey coordinator will pay particular attention to hiring and training observers for this survey (Element 6). Bird identification and distance estimation is extremely important; accurate identification of birds by sight and sound is essential and observers will need these skills prior to hiring if the bird community is diverse and the survey is recording all species. The training sessions will prepare observers to accurately estimate distances to all types of bird detections. All crew members will be issued a copy of the SSP during the pre-survey training.

General Preparation and Review—Understand the goals and procedures of the monitoring program and begin preparations for the training period and field season. Select a sampling design (SOP 1) and establish sampling points, develop a timeline and field schedule, and outline responsibilities of individual crew members. Discuss the season's plans with supervisor and Regional biological support staff. Review field notes and trip reports from past sampling. Identify any unique species or conditions (hazardous routes, missing markers, etc.) that may be encountered.

Scheduling Field Work—Establish the survey schedule. Breeding bird surveys should coincide with the peak breeding activity of most landbird species in the study area. Sampling schedules often change due to weather events. It is wise to plan for weather days throughout the month and always have a backup plan. Under good access and walking conditions, crews can sample from eight to 14 points a day.

Organizing Supplies and Equipment—Organize and prepare all field equipment several weeks before beginning field work (SM-2). Verify that all equipment is in working order before field work begins. It is useful to attach brightly-colored flagging or spray paint items like thermometers, binoculars, GPS units, and any other equipment that may accidentally be left behind or dropped between points.

Establishment of sampling units

Generate a list of coordinates for all points to be surveyed. See SOP 1, Sampling Designs, and SOP 2, Marking Survey Locations. Include GIS-generated points for new points and a list of the actual marker coordinates for previously sampled points. Print and laminate maps of point locations for each crew member.

Upload waypoints (the latitude and longitude coordinates for each survey point) onto the GPS units. GPS units should be set to WGS84. (Points entered into the AKN database should be in lat/long WGS84.) For grids that have been sampled in the past, print a list of the actual point coordinates. Also produce a list of the point sequence and times of surveys. The survey crews will complete GPS training before field work begins. Upon completion of the training, all crew members are expected to know how to mark a point, enter new waypoint coordinates, and navigate to a waypoint using a GPS. GPS technology is evolving rapidly; permanent, on-the-ground markers may not be necessary if points can be relocated with acceptable accuracy using only the GPS unit.

If permanent markers are planned, establish and mark the sampling points before the bird surveys begin. In forests, leaf-off conditions will enhance the performance of your GPS units. Fall or early spring are ideal times for this work. Also in forests, it may be useful to flag the route used to travel from one point to the next. Much time can be lost searching for a single marked tree in dense forest, especially if GPS reception is poor under the canopy or in rough terrain.

Data collection procedures

This survey entails detecting and counting birds by species and validating the vegetation classification of each sample unit. The procedures for documenting bird observations are described in SOP 3. Procedures for documenting the vegetation classes associated with each survey point are in SOP 4. Pre-print data sheets for each survey point (SM 4). Fields to define and print on each data sheet are highlighted on SM 4. It is a good practice to print some data sheets onto waterproof paper for recording data during wet or misty days.

Processing of collected material

This protocol does not call for the collection of biotic tissue or abiotic materials. If an unusual number of injured or sick birds are observed, contact the Wildlife Health Office to determine if and how specimens should be collected and processed for shipping to the appropriate lab. Suspicious or unusually high-number of mortalities should be reported to wildlife health officials regardless of whether materials were collected.

End-of-season procedures

Clean all equipment before storage. Clean all field gear, including binoculars; re-shelve reference materials. Wash any government vehicles & boats that were used to access field sites and address any needed repairs or maintenance. The crew leader(s) will use a check-out, check-in procedure for all equipment to ensure that issued items are returned and/or accounted for. Organize any damaged or incomplete equipment, including labels describing any problems, and distinguish between functional and dysfunctional gear for the following year. Repair damaged equipment whenever possible. Compile a list of needed purchases or repairs and give this list to the survey coordinator.

Archive the original data sheets and all digital files associated with the survey (see also Element 4).

Element 4: Data Management and Analysis

Data entry, verification, and editing

Data from this survey will be entered into the Avian Knowledge Network's (AKN) centralized, online database; this protocol is hosted by the Midwest Avian Data Center (MWADC) a node of the AKN. The AKN database archives bird survey information and associated attributes. For more information about the AKN, please see www.avianknowledge.net.

You will be ready to enter data once you have established a new survey and enter your point location information and study information into the database. If this is the first year of your survey, NWRS stations should request assistance from their regional data manager; Partner agencies should contact AKN directly (SOP 5).

Analysis methods

The objectives of your project, as defined in your SSP, will drive the types of analyses that are conducted. The analysis and reporting methods are defined at the time the sampling design is developed (Element 2, SOP 1). The data analysis has four potential functions: (1) Provide basic summaries of the data, intended for use in quality control and annual reporting. (2) Estimate bird species detection probabilities, densities, or occupancy, depending upon management objectives. (3) Analyze bird habitat relationships. (4) Analyze long-term trends for individual species and changes in the composition of bird communities over time.

Simple, automated data summary and analysis tools are linked to the AKN database and available through the Midwest Avian Data Center; development of additional analysis tools is ongoing. Currently, AKN has report functions that will summarize a list of species, counts by species, species richness, and density and relative abundances for specified locations and time periods (see SOP 5). Rare or unusual species can also be identified by inspecting these reports. Field stations can download the data for their station from the database, conduct additional analyses, and create their own graphs, GIS maps, and other descriptive reports.

Population Trend and Habitat Analyses—Comprehensive analyses should be carried out periodically (e.g. every 3-5 years) using appropriate statistical methods. In most cases, consultation with a qualified statistician will be needed at the time of the analysis, as statistical methods and software evolve rapidly. Alternatively, a statistician can be contracted to conduct the analysis.

There is a well-developed literature on trend analysis of bird data to draw upon when deciding on the analytical approach (Ralph et al. 1995; Nur et al. 1999). Thomas (1996) summarized the wide variety of statistical approaches for evaluating bird population trends, which generally emphasize regression approaches that model population size (or an index) versus time. Differences arise in how the methods incorporate co-variables, the assumed distribution of residuals, variance estimation technique, and weighting approaches. MacKenzie et al. (2003) described a technique for evaluating trends in site occupancy rather than population size. Regardless of the trend analysis method that is chosen, there will be three critical issues to address: 1) how to integrate the information from multiple survey stations into a regional estimate of trend, 2) how to account for sources of variability, and 3) how to deal with heterogeneity in detection probability.

There is also a long history of analytical approaches to develop relationships between bird abundance or occupancy and habitat characteristics (Morrison et al. 1992; MacKenzie et al. 2002; Scott et al. 2002). Usually, habitat is characterized by measurements of vegetation or land use. This protocol framework does not provide guidance on measurements of microhabitat structure and composition because these will vary greatly among vegetation types, and with the objectives of each bird survey. To associate bird species with microhabitat characteristics, the SSP will require a protocol and database for monitoring of microhabitat measurements.

Birds as Indicators of Ecosystem Integrity or System Change— Birds are often used as indicators of the health or integrity of an ecosystem. Healthy ecosystems have a 'signature' set of bird species; degraded systems have higher numbers of generalist species and fewer specialist species (Browder et al. 2002). The role of birds as indicators of ecosystem health has been investigated in specific habitats and ecoregions (Brooks et al. 1998; O'Connell et al. 2000; Glennon and Porter 2005; Gardali et al. 2006; Howe et al. 2007b). An analysis of the bird community from this perspective is useful if there is a known benchmark for comparison with the target data set. For example, plant ecologists have assigned 'coefficients of conservatism' (C values) to plant species and they conduct floristic quality assessments to rank wetland restorations and compare them with natural wetlands (Lopez and Fennessy 2002; Mushet et al. 2002).

Ideally, a scoring system could be applied to bird species that would integrate their level of specialization, density or occupancy at a site and perhaps trend, resulting in an overall site-specific 'bird quality assessment' score. If your survey objectives require knowledge of ecosystem integrity based on types and numbers of birds observed, consider the methods provide by Howe et al. (2007a; 2007b) (Gnass Giese et al. 2015). These investigators developed a probabilistic indicator of ecosystem condition by integrating individual bird responses to landscape disturbance into an overall bird assemblage metric. While this approach requires calibration for a particular ecological system, it is transparent, fairly simple to implement, and could be applied to any region.

Likewise, long-term monitoring of bird populations may alert managers when changes are occurring that indicate a need for a management action or decision. If this is an objective for conducting the survey, then consider using a control chart for summarizing the survey results. Although there are few examples of control charts applied to ecological data (Scandol 2003),control charts are widely used in industrial and health care applications to summarize monitoring information and identify outliers, indicators that the system is going 'out of control' (Guthrie et al. 2005; Mohammed et al. 2008). There is potential application for control charts in environmental monitoring in a management context; outliers may signal the need for management actions (Anderson and Thompson 2004; Morrison 2008).

Element 5: Reporting

As described in other elements, the management decisions, management objectives, and survey objectives documented in the SSP will shape the nature of the reports. Ideally reporting should restate survey objectives and link findings to management decisions. Annual meetings between station managers, biologists, and survey coordinators will facilitate the application of results to management decisions. Annual meetings will also help managers and other station staff provide feedback to survey and project coordinators regarding how well the reports are meeting their needs. Such meetings are valuable for both interpretation of survey results and improving the project through good communication. Any needed modifications to the survey design or protocol can be discussed at this time.

Report distribution

The SSP will identify to whom reports will be delivered and the appropriate medium for communications. A strategy for archiving reports should also be described. FWS cooperators should ensure that field notes and reports are stored in compliance with Service Enterprise Architecture (270 FW 1), Data Resource Management (274 FW 1), and Electronic Records (282 FW 4) policies. Refuge System staff should also create accurate metadata and store data documents, metadata, reports, posters, graphs, maps, and any other documentation of results in ServCat (701 FW 2).

Type of reports

There are several ways for reporting the results of a survey including progress, annual or synthesis reports that are completed after longer intervals of monitoring. Each of these types of reports has a particular purpose and varies in the reported content, as described below.

Progress Reports—Brief quarterly or semi-annual reports document accomplishment of benchmarks laid out in contracts or agreements. The schedule and benchmarks are generally defined in the original contract or agreement.

Annual Reports—Annual reports summarize the data collected that year for each station and the project as a whole. Field sampling typically runs from May-July each season, with data analysis and report writing to be accomplished prior to the start of the subsequent field season, by April of the following year. Purposes of the annual reports are to:

- Check for errors - missing data, outliers, data entry errors. The sooner these errors are discovered, the more likely it is that they can be successfully addressed. Data quality in future years will improve through learning about the problems that can arise. Exploratory data analysis tools are very useful for error checking (Morgenthaler 2009).
- Document monitoring activities and archive data for the year.
- Describe the current condition of the resource and provide alerts if data are outside bounds of known variation.
- Provide information about bird populations and their habitats associated with management actions and decisions.
- Document any important problems, constraints, or changes in monitoring protocols that occurred in that year.

Annual reports should include:

- The date range of the sampling events.
- Map of sampling locations (GPS coordinates).
- Crew members, full names and initials, and their responsibilities.
- A list of bird and other faunal species encountered; include useful standard reports produced by the database.
- A table of all species observed with total number of observations, and estimates of relative abundance and detection probabilities.
- Maps of the spatial distribution of species in the station.
- Cumulative tables of total abundance (corrected for effort) and frequency of occurrence (proportion of sites where species was detected) vs. year for each species.
- Reports of rare species or unusual occurrences.

- General observations of weather, bird behavior, and other animals.
- Any discrepancies that might affect data integrity/consistency.
- Potential hazards.
- Unique or noteworthy events.
- Recommendations for any changes to the protocol, equipment that should be repaired or replaced.
- Advice for future survey crews.
- Acknowledgement of unpaid volunteers who contributed to or supported the survey.

The AKN database can generate some simple reports data.pointblue.org/science/biologists/. The analysis tools may be found at data.prbo.org/apps/analysts/ or by clicking the *Analyze Observations* link under Project Management Tools. Bird summaries include frequency, average abundance, average count, birds/hour, maximum count, and total count for a user-defined period, scale, and taxon. A data export function allows users to summarize data outside of the AKN database.

Synthesis Reports —The survey coordinator produces synthesis reports (every 3-5 years) and submits them to the station manager. Purposes of the synthesis reports are to:

- Document statistical methods
- Evaluate patterns/trends in condition of resources being monitored.
- Discover new characteristics of resources and correlations among resources being monitored.
- Analyze data to determine amount of change that can be detected by this type and level of sampling.
- Context – interpret data for the station within a regional or national context.
- Make recommendations regarding management decisions.
- Provide a comprehensive list of people, including paid and unpaid contributors, who participated in or supported the survey.

Other reporting venues

In some cases, other means should be used to disseminate inventory or monitoring results. These include publication or presentation to relevant audiences, which are important venues for communicating to the scientific community or public.

Scientific Journal Articles and Book Chapters—When final reports are of sufficient breadth, significance, or quality, publication in either a Service format or an appropriate scientific journal is encouraged (U.S. Fish and Wildlife Service 2007). Purposes of these peer-reviewed publications are to:

- Document and communicate advances in knowledge.
- Make recommendations relevant to management that may be useful at locations beyond the scope of the survey itself.
- Allow for scientific peer review.

In preparing the Annual Habitat Work Plan, the station manager should plan and budget for writing of manuscripts suitable for submission to peer-reviewed scientific publications, as findings warrant. In these cases, the survey coordinator should prepare or coordinate the writing of manuscripts, submit them to the station manager for review, and then to an appropriate publication outlet (U.S. Fish and Wildlife Service 2007).

Other Symposia, Meetings and Workshops—The FWS encourages participation in biological symposia, meetings and workshops, at regular intervals. Purposes of participation in these activities are to:

- Review and summarize information on a specific topic or subject area;
- Communicate latest findings with peers;
- Help identify emerging issues and generate new ideas.

In preparing the Annual Habitat Work Plan, the station manager should plan and budget for staff to participate in symposia, meetings, and workshops. The survey coordinator should seek out opportunities to share the results of the monitoring program and submit abstracts for upcoming symposia, meetings, and workshops.

Reporting schedule

For progress and final reports, the SSP should clearly specify the frequency and expected due dates of reports. A short-term inventory effort may produce only a final report soon after the all data are collected and analyzed. Whereas longer-term monitoring efforts are likely to require both progress reports and a final report. Surveys funded by special grants will generally require annual, interim reports as well as final reports. The established frequency and timing of reports should be integrated with the frequency and timing of the management decision-making process. For long-term ($\geq$ 10 years), the survey coordinator should plan and budget for an analysis and report at least every 5 years. Synthesis reports that also provide answers to ecological questions or management responses should be peer-reviewed and published.

Element 6: Personnel Requirements and Training

Personnel involved in a survey may be as few as a manager and a biologist who serves as the survey coordinator and observer. Larger projects may include a project coordinator who oversees the entire survey at multiple stations or even Regions, survey coordinators who oversee the survey at each station, bird observers who conduct the surveys, a data manager, and data entry staff. It is important to understand the roles and responsibilities of the people involved in the survey to ensure that all roles are staffed.

Roles and responsibilities

Station Manager or Regional Office Manager—The survey coordinator is usually supervised by the station manager or the supervisory biologist at the station. In some situations the survey coordinator may report to the regional office. The survey coordinator's supervisor is responsible for reviewing monitoring plans, reports, and making the best use of the monitoring information to improve management.

Survey Coordinator—The survey coordinator is a USFWS employee that oversees the implementation of one or more survey protocols that adhere to standards of scientific excellence

(701 FW 2). The survey coordinator plays a key role by assuring that each phase of a survey is conducted properly and completely. When surveys involve implementation by cooperators or partners, the survey coordinator ensures that the I&M policy (701 FW 2) requirements for surveys are met.

The survey coordinator is responsible for ensuring the quality of the following activities:

- Define management and sampling objectives
- Define how the information will be used to inform management
- Select an appropriate sampling design to meet objectives
- Prepare a budget for staff time and operations
- Hire & train observers, prepare for field sampling
- Assess whether or not individual staff members possess the necessary competencies (e.g., bird identification skills) to conduct surveys
- Oversee data collection
- Supervise data entry and provide quality assurance
- Archive and share the data, providing metadata
- Analyze data and report results

The survey coordinator will delegate some functions to the appropriate staff as needed, such as preparing field gear and data collection equipment, supplies, and data forms for the field season; entering field data into the Bird Point Count database; and cleaning, repairing, and storing field equipment. Cooperative Agreements with Bird Observatories, Audubon Clubs, or contractual agreements are possible sources of staff or volunteers with bird identification and other skills. USGS Science Centers and universities have statisticians, quantitative ornithologists, and students that may be available to help with data analysis and reporting.

Survey Assistants/Field Crew Members—Survey assistants and other field crew members may be employed biological technicians, volunteer interns, or citizen scientists. Depending upon the scale of the monitoring effort, one or more field crew leaders may need to be assigned to assist the survey coordinator in overseeing implementation of some survey phases. Because of the need for a high level of training and consistency in implementing a survey protocol, the survey coordinator should oversee the hiring and training of the field crews and, when possible, participate in field surveys.

The field work can be implemented by a single observer. However, it is more efficient if the bird observer is assisted by a recorder who assists with recording and transport of equipment. Also, observers working alone in the field raise safety considerations; they are more vulnerable if an accident occurs. Observers must also be physically fit enough to navigate to the sampling points and able to arrive at their study site(s) approximately 15 minutes prior to sunrise.

Data Managers—Data management is the shared responsibility of the survey coordinator, the AKN (database host), and each USFWS Region or other users of the database. The AKN is responsible for electronic data archiving, data security, dissemination, and database design. AKN, in collaboration with the NWRS Natural Resources Program Center, also develops data entry forms and other database features as part of quality assurance and automates report generation. The AKN is responsible for ensuring that adequate quality assurance procedures are built into the database management system and appropriate data handling procedures followed; the survey coordinator, with possible assistance from a data manager, is responsible for ensuring that data entry and proofing procedures meet quality standards. Survey assistants that collect and enter data are also responsible for providing quality data that will be available in the AKN. Each Region or other user is responsible for providing general training and technical support for the AKN database. The AKN database provides a means for users to notify AKN regarding technical errors or recurrent problems with the database.

Qualifications of field crew
A competent observer is the essential element in the collection of accurate data on birds.

Observers should be able to:

- Use a range finder, GPS, and digital camera
- Safely and accurately implement SOPs
- Accurately record and proof data

Hearing—Hearing is fundamental to bird identification because a large proportion of birds are heard but not seen, particularly in forested or dense shrub habitats. We recommend that observers have a hearing test; hearing loss that exceeds 20 dB will compromise their ability to effectively survey landbirds (Kepler and Scott 1981).

Training
Training for field crew members includes how to assess vegetation classifications in the field, conduct the bird observations, and use the database. Safety training is needed to safely navigate to the survey locations.

Verifying Standardized Vegetation Classifications in the Field—Training will be needed to ensure that field staff can recognize and verify the standardized vegetation classification printed on the field data sheet. If the printed class is incorrect, they need to identify and circle the correct class, found on the reverse of the field data sheet (SM 4). The attributes of vegetation classes likely to be encountered at any of the survey locations should be reviewed during training and field trips arranged to visit examples of these vegetation classes. The types of disturbances likely to be encountered and how to document them should be reviewed.

Bird Observer Skills—Observer bias is a major source of bias in trend analyses of bird populations (Sauer et al. 1994; Kendall et al. 1996). Training has been shown to improve the ability of observers to detect birds (McLaren and Cadman 1999). Training is particularly important each year, as the misidentification of a species is a serious error.

Observers must be capable of identifying the majority of birds (≥90%) targeted by the protocol. The University of Wisconsin, Green Bay has developed a Birder Certification Program (http://www.uwgb.edu/birds/certification/index-1.htm) for the midwestern and northeastern USA. This website allows bird observers to certify their skills in identifying birds by sight and sound. Field stations who engage observers to conduct bird surveys can verify that their observers have been certified. Field stations within the geographic range of this program are encouraged to use the certification process to find skilled observers and ask their field observers to get certified.

Bird observers should evaluate and improve their birding skills well before the field season begins. A minimum of one week of on-station bird identification and survey training is recommended before bird surveys begin. If the station requires observers to have safety, first aid, computer security, or other training, the survey coordinator should plan on a minimum of two weeks of training prior to beginning surveys. Regardless of skill level, birders should spend time in the field familiarizing themselves with the birds in the survey area prior to starting a survey.

Review field sampling methods (Element 3, SOP 3). Observers from previous seasons normally do not need as much annual training in bird identification skills as new observers. However, we recommend that all observers participate in training each year. Experienced observers can assist as additional teachers with less experienced trainees. Experienced observers will also continue practicing distance estimation, working on identification of birds by call notes, partial songs, and generally improving their identification skills.

New observers will be tested by accompanying a qualified observer along a route and simultaneously recording the birds detected. In addition, an examination may be given using a recording of bird vocalizations or bird vocalization software (for current resources, see http://www.partnersinflight.org/education.cfm). Even observers certified by the Birder Certification Program should have their skills evaluated in the field.

Conduct the majority of the training in habitats and topography similar to those encountered during surveys. While emphasizing distance estimation, point out as many birds as possible with the initial objective of maximizing the trainee's exposure to the species most likely to be encountered during the surveys. Discuss personal techniques for accurate recording, dealing with busy points, flyovers, moving birds, and potentially confusing scenarios, bird species and behaviors that are encountered in similar habitats.

Start training days early. Problems enumerating individual birds during the "dawn chorus" can lead to erroneous survey results. Thus, adjust the training time to best prepare observers, incorporating the peak singing time for most species. An early training time also allows crew members to become accustomed to waking up early, which will be crucial when the real surveys begin.

Suggested reference materials for learning to identify birds:

- Dendroica, http://www.natureinstruct.org/dendroica/
- Several apps are available for handheld devices that provide drawings or pictures of the birds and audio of the species' vocalizations. When loaded onto a cell phone, they are extremely useful tools that can be carried into the field to verify a song or visual ID.
- National Audubon Society Interactive CD-ROM Guide to North American Birds. This interactive CD-ROM is an excellent resource for learning calls, onsite ID, and background information on bird species.

- National Geographic. Current edition. Field Guide to Birds of North America. National Geographic, Washington, D.C.
- The Sibley Field Guide to Birds of Eastern North America. Current edition. Alfred A. Knopf, New York.

Recording Time of Detection—We will be primarily using the time removal method (Farnsworth et al. 2002) to estimate detection probabilities. This method assumes that a bird has an equal probability of first being detected within any of ten, 1-minute time intervals. To avoid biases, observers must be trained to record individual birds the first time they are detected and attribute them to the minute indicated by the digital timer. In practice, it may be difficult to record all the birds detected within the first minute before the timer rolls over to the second minute. For this reason, most analyses of the data will combine the first two minutes. Accurate recording will require practice during the training period. For example, recording all the loud birds first will result in biased population estimates. To avoid biases, record all individual birds the first time they are detected and attribute them to the minute indicated by the digital timer.

Distance Estimation—Distance estimation is a secondary method of estimating detection probability in this protocol. Therefore, observers need to record birds as accurately as possible within the distance bands. The majority of birds are usually heard but not seen, and estimating distances to birds that are only heard is often the greatest source of error in point counts (Simons et al. 2007). Refer to Kepler and Scott (1981) for a detailed discussion of training observers to identify birds by sight and sound as well as training them to estimate distances.

Use a range-finder to practice estimating distances in each general habitat type that will be included in the survey. Walk around a point location placing flagging at 4 or 5 locations visible from a central point. Return to the central point and estimate the distance band (e.g. 0-25m, 26-50m, 51-100m, > 100m) that each flag falls within, recording them in a field book. Use a range-finder to evaluate the accuracy of each estimate. Repeat this exercise several times until you can consistently estimate distances.

Standing at the central point, listen for vocalizing birds. Choose one consistently vocalizing individual and estimate the distance band in which it is singing. Try to visually identify the tree or branch where you think the bird is, and use a range-finder to estimate the distance to an object near where you think the bird is vocalizing. Mark your location. Walk toward the vocalizing bird until you can either see it or accurately estimate its location. Compare your initial estimate to the actual distance between your survey location and the bird. Repeat this exercise for several birds at various distances.

Safety Training—Basic safety training includes first aid and CPR. Specialized vehicles (ATVs, boats, planes) will require additional safety training. Plan far enough in advance to schedule the necessary safety training for all field staff. During training sessions, review safety procedures, first aid, what to do in case of an accident or injury, how to file a daily 'float plan', and how to check in with a responsible party at the end of each day, etc. Daily and weekly safety reminders during the field season will help reduce accidents.

Technical Equipment—The survey coordinator will ensure that observers understand and are trained to use all the equipment and SOPs needed while they are in the field, including motorized vehicles, GPS navigation equipment, cameras, and emergency communication equipment (e.g., radios or cell phones).

Element 7: Operational Requirements

Considerations regarding operations include operational costs, staffing, and the frequency of the surveys.

Budget

Station Costs—Cost estimates in Table 7.1 are derived from general experience with conducting point counts. Most stations will hire biological technicians to conduct the surveys because of the specialized training required and the time commitment; two technicians are recommended for safety considerations, although one person could undertake the surveys. Equipment costs are based on on-line retail prices for moderate quality optical and field survey equipment. (Some stations will already own some of the needed equipment.) Cost amounts are given in 2015 dollars; annual inflation factors of 2 to 4% can be applied to quickly predict costs in subsequent years. Current prices of equipment should be obtained from vendors when writing the SSP.

Table 7.1. Estimated annual costs for survey at one station (~130 points, one annual visit)

	Staff (weeks)							Operational Expenses		
Staff	Plan	Select & mark sites	Data collec-tion & entry	Data anal.	Report	Total Wks	Total FTE[1]	Staff	Fuel	Equip.
Coordinator[2]	2	1	1	2	2	8	.16	$12,000		
										$1200
Technicians[3]		4	20			24	.48	$16,000	$400	
Total						23	.64	$28,000	$400	$1,200

[1] A full time equivalent, one employee or volunteer for a 2080 hour year
[2] The designated survey coordinator at the station.
[3] Assumes two survey assistants (biotechs) hired for 3 months, ~$8K per person = $16K for bio techs for one year.

Staff Time

The number, size, spatial arrangement, and accessibility of survey units influence the staff time required to conduct the survey. The effort required to complete a survey route is expected to vary considerably among stations due to variability in these site characteristics. For example, if sample sites are remote or only accessible by plane, the surveys will cost considerably more than average. Our cost estimate in Table 7.1 is based on average field conditions when the entry to the survey unit is accessible by car and the observer will walk between points. We estimate two biotechs for three months of work are needed, which is the usual time frame for hiring temporary summer staff. We estimated four weeks of actual survey time X four days per week X 8 points per day = 130 survey points. This allows for some days of inclement weather over a 6 week survey window and designated office days for data entry.

Schedule

Survey activities are seasonal and some are time-sensitive within the survey period. Please see Table 7.2 and Element 2: Sampling Design for information relevant to scheduling survey activities.

Table 7.2. Estimated annual work schedule.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Planning	X	X	X	X							X	X
Training				X	X							
Field Work					X	X	X					
Data Entry						X	X	X				
Analysis	X	X							X	X		
Reporting	X	X							X	X	X	

Coordination

If multiple stations or multiple agencies are cooperating on a larger survey, additional staff time will be needed for survey coordination, communication, planning, data analysis, and reporting. In general, at least 0.25 FTE of coordination time is needed for a survey with 3–10 cooperators.

Sharepoint sites are available to provide coordination and communication for multi-station (FISHNET) and multi-agency (DOI Sharepoint) surveys. For DOI participants, Google Sites can also provide a communications hub for surveys.

Element 8: References

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Standard Operating Procedures (SOP)

SOP 1: Sampling Designs and Digital Maps

Digital Maps and Mapped vegetation classes

The best available digital land cover maps of the study area can be used to select the points and plan logistics before going to the field. These maps need to accurately represent the features of the sampling frame (habitat types, elevation, proximity to roads, etc.) to meet the objectives of the survey.

Bird data will also be linked to standardized and mapped vegetation classes in the database to allow for analysis at broader geographic scales (SOP 5). For example, a future study may wish to generate a summary of grassland bird counts on refuge stations across a region or Landscape Conservation Cooperative geography. The survey coordinator will determine the vegetation classes for all the survey points and print this on the data sheet header (SM 4). This is a required field in the database.

Example Sampling Designs

This SOP provides options for sampling designs to be used with bird point counts for purposes of surveying grassland, forest, and shrub nesting landbirds during the breeding season. Users of this protocol are strongly encouraged to consult with a statistician regarding the best sampling design to meet objectives (Element 1) (Reynolds 2012).

This SOP describes four methods for selecting sampling locations, based on unit size and access. Our sampling methods require digital (GIS) maps of the study area. Multiple options for sampling designs are provided because stations vary greatly in size and have different management objectives that necessitate different sampling designs. This SOP includes one sampling design (#4) derived from the Passerine Monitoring Protocol for the Central Alaska Network (McIntyre et al. 2004).

For all but the largest management units (> 10,000 ha) the protocol relies on random or stratified random sampling. For very large land units, Generalized Random Tessellation Stratified Design (GRTS) and variations have the advantage of ensuring the spread of samples across the target area (spatially balanced) and simplifying replacement of unusable sample points (Stevens and Olsen 2004; Theobald et al. 2007; Lister and Scott 2009). GRTS is preferred for multi-stage sampling designs across ecoregions, regions, or other large areas.

All designs employ 300 m spacing between sampling points to avoid double-counting because our protocol allows recording birds farther than 100 m from the observer (Verner 1988). Survey points should avoid edges (within 50 m of target habitat edge) only if the objective focuses on bird estimates within a specific habitat type. Station-wide surveys and surveys of species that are known to occupy edges can include edge habitats.

Sample Design #1: Random Design, for Small to Large Land Units

This sampling design addresses all objectives that benefit from random selection (inventory, change over time, community composition, adaptive management, habitat associations) and is suitable for small to large land units (< 5,000 ha) when most of the target sampling frame is accessible.

Sampling units, sample frame, and target universe—Impose a randomly-placed 300 m grid over land unit (entire station or management area). Select all grid cells with > 60% of the target landbird habitat (define vegetation classes to be included). This is the sampling frame.

Sample selection and size—Randomly select 50-100 of these points to sample (more is better). If 50 cells is the target, select 50 primary + 20 replacement cells to sample (over-sampling). Locate the centroid of these cells and generate a set of points for mapping and to upload into a hand-held GPS unit. Overlay roads, trails, and other elements that allow access to target vegetation class (define for each station). This information is used to determine access points:

- Surveyors attempt to navigate to the primary sampling cells (points) (e.g., cells 1 to 50); if they cannot reach a primary cell for logistical reasons, replace it with the next cell on the list (e.g., cell 51); repeat as necessary until the full complement of cells are sampled.
- If edge habitat is not part of the target habitat, you can remove points that include edges. Depending upon your objectives, you may want to keep edge habitats in your sample.

To remove edges—If surveyors reach a sampling point that does not contain at least a 50 m radius circle of the target vegetation class surrounding the point, the point is sampled and is labeled 'edge' on the data sheet. The surveyor moves on to the next point and uses replacement (see above) to acquire data for at least 50–100 points that are not 'edges'. Theoretically, edge points could be screened out using the digital map by employing a rule that the entire 300-m cell must fall within the vegetation class boundary; however, many maps are not accurate enough to do this without field reconnaissance. It will save survey time if all the points can be ground-truthed and the edge points eliminated, if necessary, before the field season.

Sample Design #2: Stratified Random Design, Stratified by Access, for Small to Large Land Units

This sampling design addresses all objectives that benefit from random selection (inventory, change over time, community composition, adaptive management, habitat associations) and is suitable for small to large land units (< 5,000 ha) when large areas of the target sampling frame are very difficult to access and linear features (roads, trails) characterize all accessible areas.

Stratification is by access. If parts of the target sampling frame are permanently inaccessible for safety or other reasons (unexploded ordnance, technical climbing required, frequent illegal activity), remove those cells from the sampling frame entirely. Use this design (#2) if roads or trails characterize the accessible areas. Use Design #1, with inaccessible cells removed, if access is not limited to roads or trails. Caution: Once you have defined the strata, they are fixed and cannot be changed without introducing bias.

Sampling units, sample frame, and target universe—Impose a randomly-placed 300 m grid over entire station or management area.

1. Select grid cells with > 60% of the target landbird vegetation classes.
2. Overlay roads, trails, and other elements that allow access to target vegetation classes (define for each station).

3. Classify 300-m cells as accessible if they intersect the above features (roads) (Class 1) or difficult to access if they don't (Class 2). The sampling frame is the set of Class 1 and Class 2 grid cells containing > 60% of the target landbird vegetation. A statistician can use the Class 1 and Class 2 designations to check for bias and decide how to attribute estimates, if at all, to the Class 2 designations.

Sample selection and size—Select Class 1 sampling units: Extract a line coverage that represents all accessible paths (roads, trails); employ a sampling program that defines a set of points along the line coverage, with all points at least 300 m apart in all directions. Randomly select 50–100 of these points to sample. If all sampling points are on-road, distances between sampling points should be increased to 1 km (0.5 mi.) to cover more area (Ralph et al. 1995).

1. Select class 2 sampling units: Buffer the accessible line coverage 300 m, select all Class 2 cells that do not intersect the buffer. Locate the centroid of these cells and randomly select X primary + X replacement Class 2 cells to sample. These are numbered 1-XX. In consultation with a statistician, use a lower selection probability for Class 2 than used for Class 1, but one that balances logistic and precision concerns; the number of primary and replacement cells are determined in consultation with the statistician.
2. Surveyors attempt to navigate to the primary Class 2 sampling cells; if they cannot reach a primary cell for logistical reasons, they replace it with the next cell on the list, and repeat as necessary until the desired number of Class 2 cells are sampled.
3. To remove edges: If surveyors reach a sampling point that does not contain at least a 50 m radius circle of the target vegetation class surrounding the point, the point is sampled and is labeled 'edge' on the data sheet. The surveyor moves on to the next point and uses replacement (see above) to acquire data for at least 50 points that are not 'edges'. Theoretically, edge points could be screened out using the digital map by employing a rule that the entire 300-m cell must fall within the vegetation class boundary; however, many maps are not accurate enough to do this without field reconnaissance. It will save survey time if all the points can be ground-truthed and the edge points eliminated, if necessary, before the field season.

Sample Design #3: Stratified Random Design, Stratified by Habitat Type, for Small to Large Land Units

This sampling design addresses all objectives that benefit from random selection (inventory, change over time, community composition, adaptive management, habitat associations) and is suitable for small to large land units (< 5,000 ha) when most of the target sampling frame is accessible. In this design, the objective is to stratify by a factor relevant to your management objective, such as habitat type (vegetation class) when you are concerned that a simple random sample might miss or under-sample a sub-set of that factor (rare habitat type). Sometimes other factors, such as land ownership, may be of stronger interest than habitat type. With a simple random sample, it is likely that habitats that are small in area relative to other habitats may, by chance, have too few samples or none at all. Stratification, with appropriate sample selection possibilities, solves this problem.

If the objective is to obtain habitat-specific estimates of abundance or occupancy, then equal sample sizes in each target habitat are recommended or you can design the number of samples to meet your sampling objectives (confidence intervals). For example, if you have a stronger interest in public land versus private land, or if sampling variances were higher in public lands, then you would sample public land more intensively than private land.

Avoid creating strata that will change over time as this will greatly complicate the analysis (Mahan et al. 2007). A common example is habitat types that change over time due to plant succession, disturbance, etc. Your sampling time frame should be short enough to avoid strata changing from one habitat type to another. Use permanent characteristics (elevation, bedrock geology) to establish strata if you will be sampling over long time periods. The strata are defined in the office; if you navigate to a point on the ground and find that it is not the habitat you expected, you should retain the original stratum assignment. Your stratification will still effectively increase sample sizes for less common habitat types (P. Geissler, *personal communication*).

Sampling units, sample frame, and target universe—Impose a randomly-placed 300 m grid over entire station or management area. Classify 300-m cells by the dominant target vegetation classes (Habitat 1, Habitat 2, etc.). Select grid cells with > 60% cover of the target landbird habitat (define vegetation classes). This is the sampling frame.

Sample selection and size—Independently, randomly select some number of points (more is better) in each vegetation class, with some replacements if some cannot be accessed or fall on an edge. If 50 cells is the target, select 50 primary + 20 replacement cells to sample in Habitat 1; do the same for the other target vegetation classes. You can choose to allocate the samples proportional to the size of the vegetation class or you could sample equal numbers of points in each vegetation class.

Locate the centroid of the selected cells and generate a set of points for mapping and to upload into hand-held GPS unit.

1. Overlay roads, trails, and other elements that allow access to target vegetation class (define for each station). This information is used to determine the best access points.
2. Surveyors attempt to navigate to the primary (#1–#50) Habitat 1 sampling cells; if they cannot reach a primary cell for logistical reasons, they can replace it with #51; repeat as necessary until 50 cells are sampled.
3. To remove edges: If surveyors reach a sampling point that does not contain at least a 50 m radius circle of the target vegetation class surrounding the point, the point is sampled and is labeled ‘edge’ on the data sheet. The surveyor moves on to the next point and uses replacement (see above) to acquire data for at least 50 points that are not ‘edges’. Theoretically, edge points could be screened out using the digital map by employing a rule that the entire 300-m cell must fall within the vegetation class boundary; however, many maps are not accurate enough to do this without field reconnaissance. It will save survey time if all the points can be ground-truthed and the edge points eliminated, if necessary, before the field season.
4. Repeat steps 5–9 for remaining vegetation class until all the target vegetation classes are sampled.

Sample Design #4 Multi-Stage Probabilistic Design, Stratified by Accessibility, For Large Land Units

Panel designs that allow some points to be revisited annually and other points to be revisited in rotations > 1 year apart may be advantageous for long-term monitoring (McDonald 2003). Statistical consultation is advised before implementing a panel design. Design #4 uses a panel design to define the timing of revisits.

This sampling design addresses objectives associated with bird inventories, bird community composition and change over time, and habitat associations and is limited to very large land units (> 10,000 ha), where large areas of the target sampling frame are very difficult to access, and the target population is the entire station. This sampling design is adapted from a sampling design by Roland et al. (2003) that was used by the National Park Service in Denali National Park (McIntyre et al. 2004).

Sampling units, sample frame, and target universe—The target population is the entire station. Impose a randomly-placed grid (macro-grid) over entire station or management area (Stage 1). (The size of the macro-grid can be scaled to the size of the overall management unit; many units may be well served by a grid with cells 10 km on a side.) In the south-east corner of each macro-grid, generate a mini-grid consisting of a 5 X 5 lattice of 25, 300-m cells (Stage 2, Table 2). The mini-grids are your target sampling units.

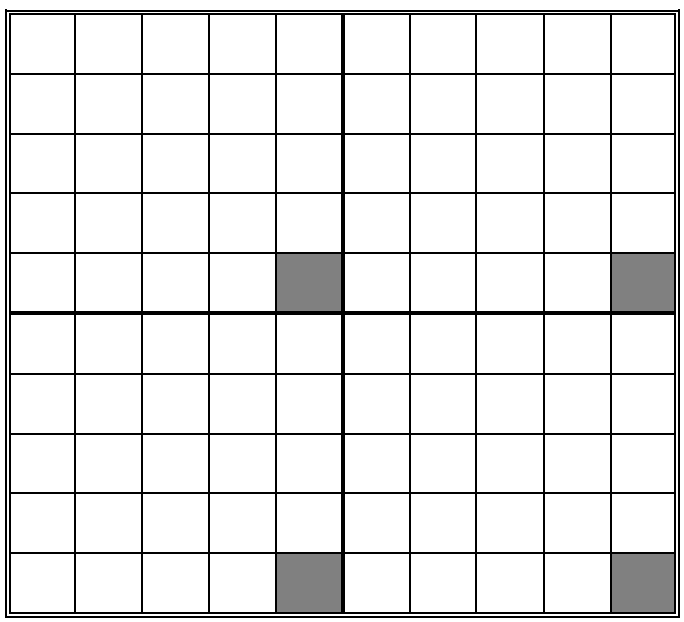

Figure SOP-1.1. Diagram of macro-grid, with mini-grids marked in gray. Each mini-grid contains 25, 300-m cells.

Sample selection and size—should be determined and allocated by:

1. On each mini-grid, overlay roads, trails, and other elements that allow access to sample points (define for each station).
2. Extract a line coverage that represents all accessible paths (roads, trails); buffer the accessible line coverage 300 m.

3. Classify mini-grids as accessible if they intersect the buffer (Class 1) or remote if they don't intersect the buffer (Class 2).
4. Use software to generate a spatially balanced sample of 50 primary Class 1 mini-grids and 10 secondary mini-grids to sample (Stevens and Olsen 2004; Theobald et al. 2007). These are numbered 1-50. These are your samples.
5. Locate the centroid of each cell in the primary mini-grids (25 points) and conduct the point count. If one or more points in the mini-grid are inaccessible, mark that on the data sheet and conduct as many as possible. If more than 5 points within a mini-grid are inaccessible, replace the mini-grid with # 51. Continue until you have sampled 50 Class 1 mini-grids, each with 20+ accessible points.
6. Randomly select 10 primary + 5 replacement Class 2 mini-grids. These are numbered 1-15.
7. Surveyors attempt to navigate to the primary (#1-#10) Class 2 mini-grids; if they cannot reach a primary mini-grid for logistical or safety reasons, they can replace it with #11; repeat as necessary until ten, Class 2 mini-grids, each with 20+ accessible points are sampled. In Denali NP, helicopters are usually required to reach Class 2 sampling points.
8. If possible, it is best to ground-truth the sampling points before the field season to finalize the set of Class 1 and Class 2 mini-grids.
9. For long-term monitoring (10 + years), a panel design should be used (Table 2).
10. The sampling frame is the full set of Class 1 and Class 2 mini-grids and these can be explicitly mapped.
11. The sampled set contains 50, Class 1 and 10, Class 2 mini-grids. Each panel contains two Class 1 mini-grids. Panel 1 is surveyed every year, Panels 2-7 are surveyed in two consecutive years every 4 years, and Panels 8- 20 are surveyed once every 12 years. The 10 Class 2 mini-grids are sampled as in Panel 8 (the first year and every 12 years thereafter); this concentrates helicopter use to once every 12 years. However, this limits the ability to estimate trends over the entire sampling frame to every 24 years.
12. A statistician can use the Class 1 and Class 2 designations to check for bias in the Class 1 data set and to allow extrapolation of sampling results to the sampling frame. Thus, the sampling frame at the local scale is the set of Class 1 and Class 2 cells across the station or management area and this area can be explicitly mapped. Panel designs will require statistical consultation during the planning and analysis phases of the survey.

Details for the Site-specific Protocol

At each station, the SSP will contain additional details specific to the implementation of the survey at that station. The examples below are not comprehensive, but provide suggestions regarding the additional content of the SSP.

- Contact information
- Station name and agency
- Survey coordinator
- Regional Data Manager

Objectives—Define the specific objective(s) for the survey, referencing the Comprehensive Conservation Plan, Habitat Management Plan, or other relevant planning document.

Sampling design—Describe the sampling design in detail. Where, when, and how will the sampling be done? If the sampling design is complex, provide enough detail that surveyors can follow the directions, find sample points, and understand what data must be collected and when. Also, provide enough detail that a statistician will know how the data should be analyzed. It is always best to consult a statistician BEFORE finalizing your sampling design.

Maps—Provide detailed maps of survey locations and list GPS locations for sampling units (transects and point count stations). Include directions for routes particularly for getting to sampling units that are off road or trail.

	Sampling Occasion																			
Panel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	X	X					X	X					X	X					X	X
3		X	X					X	X					X	X					X
4			X	X					X	X					X	X				
5				X	X					X	X					X	X			
6					X	X					X	X					X	X		
7	X					X	X					X	X					X	X	
8	X													X						
9		X													X					
10			X													X				
11				X													X			
12					X													X		
13						X													X	
14							X													X
15								X												
16									X											
17										X										
18											X									
19												X								
20													X							

Figure SOP-1.2. Proposed sampling rotation for landbird monitoring using a multi-stage design, Denali National Park and Preserve, Alaska for 24 year period starting in 2005.

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SOP 2: Marking Survey Locations

A suitably marked sampling unit is paramount for locating the place for collecting point-count data. Relocating a previously monitored point-count station can result in frustration and missed data if good maps and directions, accurate coordinates, visible markings or useful documentation are not provided. The following equipment steps can be used to get data collectors to the correct locations for sampling.

Equipment and Supplies

See SM 2 for a checklist of equipment and supplies needed to implement the field component of the protocol.

Steps

1) Generate sampling points. The survey coordinator will generate a GIS layer of sampling points using one of the sampling designs in the protocol (SOP 1, Sampling Designs) or a custom sampling design.
2) Create a map of sampling points, overlaid on vegetation map or a rectified aerial photo. The map should show useful landmarks that can be located on the ground by the observer.
3) Create a list of your sampling point locations using Geographic (Latitude/Longitude) **coordinate system** referenced to the WGS84 **horizontal datum** (Table SOP-2.1). Each point must have a unique identification number.
4) Pre-print field data sheets with the GPS locations (SM 4).
5) Upload sampling points into GPS device.

Table SOP-2.1. Example sampling point location table, horizontal datum WGS84.

PT. #	LATITUDE_DD	LONGITUDE_DD	NOTES
1	43.82169	-91.26671	From northern red oak tree flagged with pink-glo tape, go 8.5 feet at a bearing of 186 degrees
2	43.82255	-91.26782	
3	43.81996	-91.26706	
4	43.81691	-91.26629	
5	43.81424	-91.26377	
6	43.81885	-91.26515	
7	43.81785	-91.26418	
8	43.81787	-91.26270	
9	43.81581	-91.26146	
10	43.81408	-91.26068	
11	43.81216	-91.26290	
12	43.81366	-91.26346	

6) Use ArcGIS to identify the projection and datum being used by the GIS layer that contains your sampling points, by examining the Properties and Source of the layer. The GIS layer that contains your sampling points should employ the Geographic (Latitude/Longitude) coordinate system (referenced to the horizontal datum of WGS84). If any other system is referenced, use the "Project" tool in ArcGIS to change the projection and/or datum of the layer. **Do not upload data into your GPS device from a GIS layer that is referenced to the horizontal datum of NAD27 or NAD83!**
7) Delete all existing waypoints in your GPS device.
8) Upload the sampling coordinates into your GPS device as waypoints. Do not manually enter the coordinate values by hand into the GPS device as many mistakes are likely. There is software available to automate the uploading process.
   a) For Garmin GPS device users, a free software tool called DNRGPS can be used. When using DNRGPS to upload coordinates, be sure to use the SET PROJECTION function and specify the same coordinate system and datum used by the GIS layer in ArcGIS.
   b) You can download the latest version of DNRGPS from the following URL: http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html
9) Navigate to the sample point, using the GPS device
   a) Ensure your GPS device is set to the same datum as the GIS layer used during the upload process.
   b) If applicable to your device, ensure the Wide Area Augmentation System (WAAS) capabilities are enabled.
   c) Ensure your distance units are set to METERS.
   d) Ensure your GPS device is turned on and remains stationary in an open area for at least 10 minutes before you start to use the device for navigation.
   e) Select the desired waypoint you wish to navigate to and begin navigating to the waypoint.
   f) As you approach the waypoint, verify that at least 4 satellites are being used to determine your current position (3D).
   g) Once your distance to the waypoint is within 10 m, you should begin looking for the permanent marker that identifies the location of the sampling point.
   h) If this is the first visit to a new random sampling point, use the navigation mode on your GPS device and navigate within 5 m of the point (if navigation mode is not used, verify the estimated positional error value (EPE) is less than 5 m.
10) Conduct the bird survey.
11) After the bird survey has been completed, establish a permanent marker at the sampling point.
    a) The survey coordinator should establish what to do if the observer cannot get within 5 m of the sampling point. Options are returning another day to establish this location as a permanent sampling point or moving the sampling point to avoid barriers (water, etc.).
    b) If the point is to be moved, use your GPS device to record the coordinates of the new location. Ensure you collect the new location using a 3D fix with an EPE of 5 m or less (PDOP of less than 6 using Trimble devices).
12) Mark sample point with permanent marker
    a) Use a metal tag or other permanent marker to mark the sampling location. Brightly colored flagging or paint will make the location easier to locate in the short term, but flagging rapidly degrades.

   b) The tag should be affixed to be visible and permanent, given anticipated disturbances to the site (flooding, burning, etc.).
   c) Metal stakes with bright paint and a permanent label are ideal but may not be appropriate in all situations. The survey coordinator will decide the most appropriate type of permanent markers to use.

13) Record a description of the permanent marker location
   a) Describe directions to a marker using bearings and distances from natural features For example, use a compass and tape measure or range finder to determine the distance and azimuth to the permanent marker from a nearby natural feature such as a tree.
   b) Make sure the natural feature is unique enough to recognize; if not use a temporary marker like tape flagging or reflector tape (very useful for getting to sample points during pre-dawn hours).
   c) Record this information in the NOTES section of Table SOP-2.1.

References

None

SOP 3: Field Observations, Environmental Attributes and Bird Counts

Follow these procedures when collecting and recording attributes describing the local environment and bird counts at the time of sampling. Table SOP3.1 lists the attributes that are documented for each point count. Associated data collection sheets can be found in SM 4.

Equipment and Supplies

See SM 2 for field equipment and supplies.

Table SOP-3.1. List of attributes on the data sheet.

Type	Attributed To	Attribute	Required[1]
Names	Survey	Survey name	Y
	Survey	Project name (refuge)	Y
	Survey	Plot/route/grid name	Y
	Point	Point name	Y
Location	Point	Datum	Y
	Point	Lat / Long	Y
Habitat	Point	GAP Macrogroup	N
	Point	GAP Ecological System (Primary)	N
	Point	GAP Ecological System (Secondary)	N
Date	Visit	Date	Y
	Visit	Visit number	Y
Time	Visit	Start time	Y
Observer	Visit	Observer	Y
	Visit	Recorder	N
Site Conditions	Visit	Disturbance	N
	Visit	Noise	N
	Visit	Temperature	N
	Visit	Wind speed	N
	Visit	Wind direction	N
	Visit	Sky code	N
	Visit	Tide code	N
	Visit	Photos taken (Y/N)	N
	Visit	Vegetation (separate protocol needed)	N
Bird counts	Individual bird	Bird species	Y
	Individual bird	Minute first detected	Y
	Individual bird	Number of birds	Y
	Individual bird	Distance band	Y
	Individual bird	Detection type	Y

[1] Required element in the database.

Preparations

The survey coordinator will determine the timing and frequency of surveys (see Element 3: Field Methods). Prior to beginning the day's surveys, the observer prepares a clipboard with a data sheet for each point to be surveyed. Data sheets are preprinted with protocol name, point names, GPS locations and vegetation classifications.

The observer will practice using the range finder daily, before beginning surveys. The accuracy of the distance band assignment depends on the observer's ability to accurately estimate distances. The accuracy of the estimates will be affected by habitat structure, so practice in the field daily is required. The range finder can also be used during the surveys to determine distance to bird detections.

The bird counts may be done by one person or two people, with one conducting the bird observations and the other recording. The recorder will fill in the data sheet, including the environmental data, while the observer focuses on identifying the birds.

Plan to move quickly enough between survey locations to ensure a maximum number of points surveyed in one day of good weather. Do not race; the pace should allow other survey crews to repeat the points surveyed in a day of comparable weather and other conditions. A good survey day can vary from 7 to 14 points completed depending on topography, vegetation, weather and other factors.

Environmental Attributes

Location—see SOP 2: Marking Survey Locations

Weather—Surveys during inclement weather should be avoided. Whenever possible, do not survey landbirds in fog, rain or strong winds (Beaufort force > 3). Consider weather conditions before leaving. When survey conditions are questionable, the primary consideration is the observer's safety, followed by the ability to hear birds. High winds, heavy rain, or snow may prevent or delay surveys for several hours or even days. The surveys should be postponed if the weather is unacceptable for surveys. It may be necessary to assess survey conditions from the actual survey points, not from the departure point.

Discuss options for continuing surveys when weather is questionable. It may be necessary to go to the first survey points to determine if survey conditions are acceptable. The crew leader is responsible for deciding if conditions are unacceptable for surveys. Some form of communication among crews and with the office (cell or satellite phones, radios) is recommended.

Survey information—Navigate to the survey point using a handheld GPS unit (SOP 2). Assure that WGS84 datum is being used for navigation. Find the data sheet assigned to that point.

Fill in the 'Survey Information' section of the data sheet. Record the date and visit number. The visit number will be '1', unless the SSP calls for multiple visits to a point within a year. Record the full name of the observer and the recorder, if they are different. Record the start time for the bird count.

Measurements of vegetative structure and composition (optional–separate protocol needed) — Circle either 'Y' or 'N' on the data sheet (SM 4) to indicate if additional vegetation monitoring was conducted on that date. The survey coordinator will determine if additional vegetation monitoring should accompany the bird surveys and will provide the appropriate SOP in the SSP.

NWRS stations should contact their Regional Data Manager to determine how additional vegetation monitoring data should be archived, either in AKN with the bird data or in ServCat with the other survey materials.

*Digital photos of vegetative structure and composition (optional)***—**Circle either 'Y' or 'N' on the data sheet (SM 4) to indicate if digital photos were taken. Digital photographs are a rapid and inexpensive method of documenting habitat composition and structure. The biggest challenge with digital photographs is designing and implementing a tracking and documentation system so that images at each location are taken in exactly the same way over time. Each photograph must be associated with the correct location on the ground and archived in a way that future managers can find them. The survey coordinator will determine if digital photos should accompany the bird surveys and will provide the appropriate SOP in the SSP. The photos should be attached to any reports on the survey and stored in ServCat with the site-specific protocol. If digital photographs are part of the site-specific protocol, the surveyor will record on the data sheet the associated tracking information.

Hall (2002b, a) provides detailed guidance and forms for taking photographs of the site suitable for assessing vegetation structure and change over time. We recommend reviewing this handbook before designing your own photo point monitoring. Some general considerations, described more fully in the handbook:

- If the objective is to quantitatively assess change over time, two permanent markers are required at each location, one for the camera and one for the photo point. The photo point is what the camera focuses on and records. A fixed distance must be established between these two points and must remain the same each time a photo is recorded at that point. A meter board (pole with 10 cm increments marked on it) is placed at the photo point and the 1 m marker is centered in the photograph.
- Camera height and settings should be documented and replicated each time photos are taken for purposes of producing comparable photographs.
- All metadata (Study, date, location, photographer, setting, topic, etc. relevant to understanding or replicating the photo in the future) should be recorded on a sheet of light blue or gray paper and photographed at the same time as the archival photo is taken. This information must be permanently associated with the digital image file. Photos lacking this information have little or no value.

*Vegetation class***—**Verify or correct the vegetation classes printed on the data sheet. See SOP 4 - A General Approach for Associating Standardized Vegetation Classes with Survey Locations.

Table SOP-3.2. Fields on the data sheet that document the vegetation classification and associated information.

- Vegetation Class Macrogroup: [Full name from the GAP database – to be filled in by the survey coordinator]
- Vegetation Class Ecological System: [Full name from the GAP database – to be filled in by the survey coordinator]
- Is site within the designated Ecological System? Y or N
- If not, what Ecological System is it in? (refer to local list)
- ____
- Is the site within 100m of an edge or ecotone? Y or N
- If yes, what is the secondary Ecological System? (refer to local list) ____
- Disturbances (from list, multiple disturbances can be recorded): ____
- Notes about the site: ____

  ____

Disturbance—Document up to five kinds of disturbance to the vegetation at the site; the default is 'no disturbance' (SOP 4).

Table SOP-3.3. Disturbances that may affect the structure and composition of the vegetation.

Disturbances	
Animal damage	Invaded by exotic species
Chained	Mowed
Construction: building	Plowed/Disked
Construction: road	Prescribed burn
Construction: trail	Treated with fertilizer
Destructive use (non-harvest)	Treated with herbicide
Drought damage	Treated with insecticide
Flooded	Wetland: drained
Forest: clear-cut	Wetland: fall drawdown
Forest: selective harvest	Wetland: spring drawdown
Grazed	Wildfire
Hurricane damage	Wind event/blow down
Ice damage	Other (write in)
Insect damage	No disturbance

Noise levels—Classify the noise level into one of the categories found in Table SOP-3.3. Acceptable conditions for counting birds include a noise code of 0-2.

Table SOP-3.4. Codes used to record levels of background noise during bird counts. Decibel levels for commonly encountered activities are given in SM 6.

BACKGROUND NOISE CODE	DESCRIPTION
0	No background noise (BN) during most of the survey (< 40 decibels [dB])
1	Faint BN during at least half of the survey (~40-45 dB)
2	Moderate BN; difficulty hearing birds > 100 m away (~45-50 dB)
3	Loud BN; difficulty hearing birds > 50 m away (~50-60 dB)
4	Intense BN; difficulty hearing birds > 25 m away (>60 dB)
9	Not Recorded

Temperature—Record the temperature in degrees Celsius using a thermometer affixed to the clipboard.

Wind speed—Record the wind speed using the Beaufort Scale (Table SOP-3.1). Wind scale scores of 0–3 are acceptable for counting birds. Avoid counting birds at higher wind scales because it is difficult to detect some species by sound at the greater wind speeds.

Table SOP-3.5. The Beaufort Wind Scale

MPH	Beaufort[1]	Description	Appearance of wind effects
<1	0	Calm	Calm, smoke rises vertically
1-3	1	Light Air	Smoke drift indicates wind direction, still wind vanes
4-7	2	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
8-12	3	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
13-18	4	Moderate Breeze	Raises dust and loose paper; small branches are moved
19-24	5	Fresh Breeze	Small trees in leaf begin to sway
25-31	6	Strong Breeze	Large branches in motion; umbrellas used with difficulty

[1] Wind codes of 0-3 are acceptable for counting birds.

Wind direction—Record the direction from which the wind is blowing (N, S, E, W, NE, NW, SE, SW, VRB = variable) during the 10-minute point count. Wind direction may be considered variable if, during the 2-minute evaluation period, the wind speed is 6 knots (7 mph, Beaufort code <2) or less. In addition, the wind direction shall be considered variable if, during the 2-minute evaluation period, it varies by 60 degrees or more when the average wind speed is greater than 6 knots (7 mph, Beaufort code >2), For more information, see the U.S. Fish and Wildlife Service's data standard on wind direction: http://www.fws.gov/stand/standards/de_winddirection_WWW.html

Sky condition—Record the sky conditions (Table SOP-3.2). Acceptable conditions for counting birds include a sky code of 0–2.

Table SOP-3.6. Codes used to record sky conditions during bird counts.

Sky Code	Description
0	Clear or a few clouds
1	Partly cloudy (scattered)
2	Cloudy (broken) or overcast
3	Sand/Dust storm
4	Fog or Smoke
5	Drizzle
6	Snow
7	Snow/Sleet
8	Showers
9	Not Recorded

Tide conditions—When marine tides are known to influence the soil, water, or vegetation at the sampling unit, then classify local tide conditions according to the most appropriate category found in Table SOP-3.4 (from International Shorebird Survey protocol).

Table SOP-3.7. Local Tide Conditions.

Class	Description
1	High
2	Almost high and rising
3	Almost high and falling
4	Half tide, rising
5	Half tide, falling
6	Almost low, rising
7	Almost low, falling
8	Low
9	Not observed, not applicable, or observations made during more than one of these periods

Bird Attributes

For each individual bird or flock, the observer records:

- the species AOU code,
- the minute (0-9) it was first detected
- the number of birds (1, unless a flock was observed)
- the distance band (25, 50, 100, or <100),
- the observation type (audio, visual, both), and
- for flyovers- the number of birds

Distance and direction of detections by species—Bird data can be recorded as a list or mapped on the circle chart (SM 4). If you are using a 2-person crew, the observer will stand at the survey point and announce all detections to the recorder in a clear quiet voice, including species, detection type, distance and direction (For example, "White-crowned sparrow, audio, 125m, north"). The recorder documents the detections on the data sheet. The recorder informs the observer when the 10-minute period has ended.

Assign each individual bird or flock to the distance band (0–25m, 26–50m, 51–100m, >100m) where it was first detected. Estimate the horizontal distance from observer to bird, using the range finder to verify accuracy if possible. Take extra care estimating distance for birds closest to the point. Note in the comments any birds flushed by observers or that seem to be attracted by survey activity.

Assign each individual bird or flock an observation type (audio –heard; visual – seen; both – heard and seen; or flyover). If a bird or flock flies over but does not land within the survey circle, record the observation as a flyover, FLY and record the species and number of birds. If they do land, record them at the distance and time first detected on the ground or on vegetation or structures.

Time of detections—Record all individual birds the first time they are detected. Use the digital timer to record the one minute time period when each bird or flock is first detected. Record this on the data sheet with the species code or observation number. The first time period (0–1 min.) is coded '0'; the observer records the minute displayed on the digital timer (0, 1, 2 ...9). Record all birds as accurately as possible within each one minute period. This will require some practice during training. Recording all the loud birds first should be avoided, as this will result in biased population estimates. In habitats with many birds, it will be challenging to record all the birds observed in the first minute; do the best you can. Recording the first detection of individual birds or flocks among time periods is the primary basis for estimating detection probabilities.

Complete the datasheet for each point, even if no birds are detected. Fill in all data fields including Site Conditions and note, "no birds detected", in the comments field. This will document that the 10 minute survey was completed at this point. Ensure that all data fields are filled in before moving to the next point. Add any factors that may affect data quality to comment fields.

Additional Procedures

Other natural history observations can be recorded under 'comments' (optional).

Ensure that no equipment is left behind before navigating to the next point, using the GPS unit.

Upon returning to base, review all data and field notes for accuracy and completeness. At the end of the day, all bird detections should be legibly transcribed to the front of the data sheet (Bird Detections) for easy entry to the AKN data base. Refer to SOP 5: Data Entry and Management for instructions regarding data entry into the central database.

References

Hall, FC. 2002a. Photo point monitoring handbook: Part A - Field Procedures. General Technical Report PNW-GTR-526. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Hall, FC. 2002b. Photo point monitoring handbook: Part B - Concepts and analysis. General Technical Report PNW-GTR-526. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

SOP 4[1]. Assigning Standardized Vegetation Classes to Sample Units

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Date: June 2015

Introduction

Linking natural resources surveys to a standardized set of vegetation classes increases the long-term value of the survey data and supports data analysis at broad spatial scales (landscapes or ecoregions). The vegetation class associated with each sample unit is an important attribute (covariate) that may be needed for future, currently unanticipated, applications of the data set. *At a minimum, most natural resource surveys should document the information describing the environment associated with each sampling location.* For some surveys, this will suffice for documenting vegetation conditions. For other surveys, additional environmental attributes (plant species cover estimates, stem counts, water temperature, etc.) will be needed and separate SOPs for collecting this information will be needed.

This SOP provides guidance for associating standardized and mapped vegetation classes (hereafter referred to as 'vegetation classes') with natural resources data collected at points or polygons. The SOP can be used in any terrestrial or wetland survey when a minimum documentation of vegetation is needed. (Marine systems are not included at this time.) Survey coordinators can link sample locations with vegetation classes in advance of the field season and print them on the field data sheets and project maps. One advantage of this approach is that field staff with minimal botanical training can verify that the associated vegetation class is found at the survey location or, if the assignment is incorrect, can assign another vegetation class from a short list of those found in the study area.

How Are Vegetation Classes Standardized and Mapped?

Ecological systems are recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. These ecological systems are represented by standardized and mapped vegetation classes that are readily identifiable by trained observers in the field (Comer et al. 2003). Several federal and NGO agencies employ these standards and have developed useful tools; we employ the USGS GAP Analysis Land Cover Map. The GAP maps use vegetation classes from NatureServe's Ecological System Classification (Comer et al. 2003) and the National Vegetation

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[1] This SOP can be used to document standardized vegetation classes for other purposes, such as surveys of other biota. Therefore, it is a 'stand-alone' SOP and can be cited independent of this protocol.

[2] Suggested citation:
O'Brien, LE & MG Knutson. 2015. Standard operating procedure: a general approach for associating standardized vegetation classes with survey locations. National Wildlife Refuge System, U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Classification System; these are the same vegetation classes used by the LANDFIRE program to model fire behavior and predict disturbance potential. The GAP map covers the entire U.S. including Alaska, Hawaii, and Puerto Rico.

The standardized vegetation classifications (defined hierarchically as Class, Formation, Macrogroup, and Ecological System) for a state, county, or Landscape Conservation Cooperative geography can be perused with the GAP Land Cover Data Viewer. If you click a location on the map, a description of the class and a range map pop up. This tool can be used to generate a master list of the vegetation classes in the vicinity of the study area. Full descriptions of the classes are available from NatureServe Explorer for states, provinces, Forest Service Ecoregions, and MRLC 2000 Map Zones. For example, a search for 'oak', with Wisconsin selected as a state, turns up a list of classes, one of which is 'North-Central Interior Dry Oak Forest and Woodland'. A detailed description is provided.

For surveys that occur in wetlands and aquatic habitats, the Cowardin wetland classification system (Cowardin et al. 1979) should be used. The U.S. Fish and Wildlife Service supports a Wetland Mapper tool that identifies the wetland type and can be used to download maps and interpret the wetland classifications.

Linking Vegetation Classes to Sample Locations

The survey coordinator will oversee the assignment of vegetation classes to sample locations. GIS technical skills are required to conduct the overlay analysis. With the sample location coordinates (and datum) in hand, the GIS technician will overlay the survey location coordinates on the GAP land cover map (available for download by regions, LCCs, states or for the whole country: here) and create a site-specific map showing the vegetation classes that the sample locations fall within and the list of sites with their expected vegetation class. Additionally, a master list of all the vegetation classes found in the study area is needed for reference, in the event that the assigned vegetation class is in error. Descriptions of the vegetation classes can be downloaded from NatureServe for states, ecoregions, or map zones: here.

The survey coordinator will prepare data sheets for each survey location and print the associated vegetation class on the data sheet. The fields shown in Table SOP-4.1 should appear on the data sheet. The database should provide a pick-list of all potential vegetation classes likely to be documented during the survey and a pick list of disturbances.

Table SOP-4.1. Fields to be added to wildlife survey data sheets or databases. (Included on the data sheet for the Landbird protocol.)

- Sample Site ID # ________________________
  (Geographic coordinates should have been recorded with survey data)
- Survey Date ____________________
- Vegetation Class Macrogroup: [Full name from the GAP database – to be filled in by the survey coordinator]
- Vegetation Class Ecological System: [Full name from the GAP database – to be filled in by the survey coordinator]
- Is site within the designated Ecological System? Y or N
- If not, what Ecological System is it in? (refer to local list)
- ____
- Is the site within 100m of an edge or ecotone? Y or N
- If yes, what is the secondary Ecological System? (refer to local list)
  ____
- Disturbances (from list, multiple disturbances can be recorded):
  ____
- Notes about the site:
  ____
  ____

Recording Disturbances

Disturbances, both natural and human-induced, can affect the condition of the vegetation and be observed at the survey location. In addition to verifying the associated vegetation class, the field observer should document disturbances (Table SOP-4.2). This includes any recent management or natural disturbances that have changed the structure or composition of the vegetation over at least 10% of the survey circle. The disturbance should be detectable by the field observer at the time of the survey; most observable disturbances will have occurred within the last two years. Some disturbances, such as tree blow-downs, may be visible much longer than two years and should be documented. If there is no observable change to the expected structure or composition of the vegetation (even if records indicate management took place; e.g. burning or grazing), then do not record as a disturbance.

Categories of disturbance can be presented as a pull-down menu in the database and multiple sources of disturbance ($\leq$ 5) can be selected (Table SOP-4.2). ‘No disturbance’ is the default value.

Table SOP-4.2. Disturbances that may affect the structure and composition of the vegetation.

Disturbances	
Animal damage	Invaded by exotic species
Chained	Mowed
Construction: building	Plowed/Disked
Construction: road	Prescribed burn
Construction: trail	Treated with fertilizer
Destructive use (non-harvest)	Treated with herbicide
Drought damage	Treated with insecticide
Flooded	Wetland: drained

Forest: clear-cut	Wetland: fall drawdown
Forest: selective harvest	Wetland: spring drawdown
Grazed	Wildfire
Hurricane damage	Wind event/blow down
Ice damage	Other (write in)
Insect damage	No disturbance

Workflow and Detailed Instructions for Documenting Vegetation Classes and Disturbances

1. Download a GAP map for your region.
2. Overlay your survey locations on the vegetation classification map and derive the Macrogroup and the Ecological System associated with each location.
3. Print the Macrogroup and primary Ecological System name on each datasheet along with the Site ID (Location name/number). Print a list of all Ecological Systems likely to be encountered at survey locations on the back of the data sheet as a reference.
4. Enter the Macrogroup and Ecological System name into the database when the locations are set up. Ensure that pick lists for the vegetation classes and disturbances are correctly set up in the database for data entry.
5. Print the pick-list of potential disturbances (Table SOP-4.2) on the data sheet.
6. Train observers to recognize, on the ground, the Ecological Systems associated with survey locations in the study area and any other potential Ecological Systems they may need to record.
7. Field observers will verify, in the field, that the primary Ecological System assignment to each survey location is accurate or note on the data sheet what the correct classification should be (referring to the list on the back of the data sheet).
8. Secondary Ecological System designations will be made on location (in the field) by the observer or recorder. *The secondary Ecological System is identified only if a different Ecological System is located within 100 m of the sample site.* Stated another way, locations that have secondary Ecological Systems have an edge or ecotone within 100 m. The error associated with many digital maps requires that this designation be made in the field. The secondary Ecological System name field in the database will be 'NA' as a default and will be updated as needed by the survey coordinator after field verification.
9. Field observers will document up to 5 types of disturbances that they observe at the survey location on the data sheet; record 'none' if no disturbances are observed.
10. Enter the vegetation class and disturbance information into the database, along with other field observations.
11. Archive the GIS maps used to select the sample locations and the GAP maps used to assign the classes, along with other survey materials, in ServCat. This will allow for post-hoc analysis of attributes of the survey location such as distances to edges, level of fragmentation, size of patches, etc., that may prove useful in the future.
12. If the survey coordinator needs assistance with GIS maps and overlays, contact the Refuge System Inventory and Monitoring Program for assistance.

References

Comer, P, Faber-Langendoen D, Evans R, Gawler S, Josse C, Kottel G, Menard S, Pyne M, Reid M, Schulz K, Snow K, and Teague J. 2003. Ecological systems of the United States: a working classification on U.S. terrestrial systems. NatureServe, Arlington, VA.

Cowardin, LM, Carter V, Golet FC, and LaRoe ET. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31, U.S. Fish and Wildlife Service, Washington, D.C.

SOP 5: Data Entry and Management Instructions

This SOP provides instructions for data management, including data entry, verification, archiving, metadata, and database administration for this protocol.

Metadata

Clear documentation and standardized archiving methods will be needed to interpret the data long after the staff involved in collecting the data have moved on. Metadata describes information about a dataset, such that a dataset can be understood, re-used, and integrated with other datasets (USGS Data Management). Information described in a metadata record includes where the data were collected, who is responsible for the dataset, why the dataset was created, and how the data are organized. Metadata generally follows a standard format, making it easier to compare datasets and to transfer files electronically. The U.S. Geological Survey provides detailed guidance regarding the full cycle of data management.

The USFWS Regional Data Manager can assist the survey coordinator with all aspects of data management. The AKN captures some metadata. Many additional details about the survey are documented in the SSP; this information is also part of the metadata for the survey. In addition, an administrative record of the survey (SM 5: Project Record) should be maintained to record administrative information, document changes in the survey and other historical information about the survey (SM 5). The SSP and the Project Record, together document the information that will be needed for full reporting.

The Avian Knowledge Network (AKN) Database

Data collected using this protocol is to be entered into the Avian Knowledge Network (AKN) database portal at the Midwest Avian Data Center (MWADC) (Koch et al. 2010). For all cooperators, Point Blue Conservation Science (PBCS), an AKN affiliate, will host the database on its servers. For hosted databases, PBCS provides (1) incremental daily backups onsite, (2) weekly offsite backups, and (3) semi-annual backups that occur offsite at Cornell University.

- Contact for the Midwest Avian Data Center (data entry and reporting portal) – Katie Koch; Email: katie_koch@fws.gov; Phone: 906-226-1249.

How is an AKN project defined?—In the AKN, projects are defined around data access and data ownership. AKN Projects are the fundamental atomic unit of data ownership and all registered members of a project have access to (i.e., can add, delete, edit & download) data from the project.

Who has access to projects in the AKN and what roles are defined?—You may join an AKN project under one of four roles: Project Leader, Analyst, Biologist and Citizen Scientist. The first three roles are described below. The latter, Citizen Scientists, is a reserved role for non-professionals to enter data for specific projects.

Who is a project leader in the AKN?—Each project in the AKN must have at least one AKN Project Leader. The three responsibilities of AKN Project Leaders3 are to review, publish, and share (see AKN data access levels below) data from the project, to grant/revoke others' access request to the project, and to review and grant/revoke data requests from third parties. AKN Project Leaders can download all the data and metadata about the project, including geospatial data for sampling units, researcher names associated with the project, and all the observational data, among other things. AKN Project Leaders may allow others to join their projects as additional AKN Project Leaders and they can review who else has access to a project.

Who is an AKN biologist?—An AKN Biologist is a person who enters, edits, and proofs data. He or she is often the person collecting the field data, or just transcribing from field notes. AKN Biologists can download event and observation data, usually for proofing purposes.

Who is an AKN analyst?—AKN Analysts are persons granted the use of the Analyst tool to generate simple summaries and visualizations of the data. Analysts can also download warehouse data (i.e., a much simplified and filtered table of the data used for the visualizations).

Gain access to the database—If this is an ongoing survey, the project should already exist in the AKN database and there is a designated AKN Project Leader (survey coordinator). For new surveys, NWRS stations should contact their regional data manager for assistance. Partner agencies can contact AKN directly. Before a new survey can be created, the AKN Project Leader (survey coordinator) will write a SSP that defines the specific purpose for the survey, documents the sampling design, and provides maps and lists of selected management units and sampling points with associated GPS locations (See the Survey Protocol Handbook for details). The AKN Project Leader (survey coordinator) will need the information in the SSP to create sample points for data entry (SOP 1. Sampling Designs and Habitat Classification).

Identifying information (Names)—A Project can include one or more Studies (Fig. SOP-5.1). For NWRS stations, the Project name is the name of the refuge; other agencies can set their own

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[3] In this protocol, the AKN Project Leader role is synonymous with the survey coordinator role. In the NWRS the official job title of a refuge manager is 'Project Leader', which causes confusion with names and roles defined by AKN.

conventions. There can be multiple Studies ongoing at a station. The plot/route/grid may be a management unit or part of a management unit.

A cooperative study may include multiple Projects, perhaps from multiple agencies (Fig. SOP-5.2). Currently, the AKN database does not recognize this higher level of organization. A work-around is for the cooperative study coordinator to be named as an AKN Project Leader for each participating Project; data sets from multiple Projects can be combined outside of AKN for analysis.

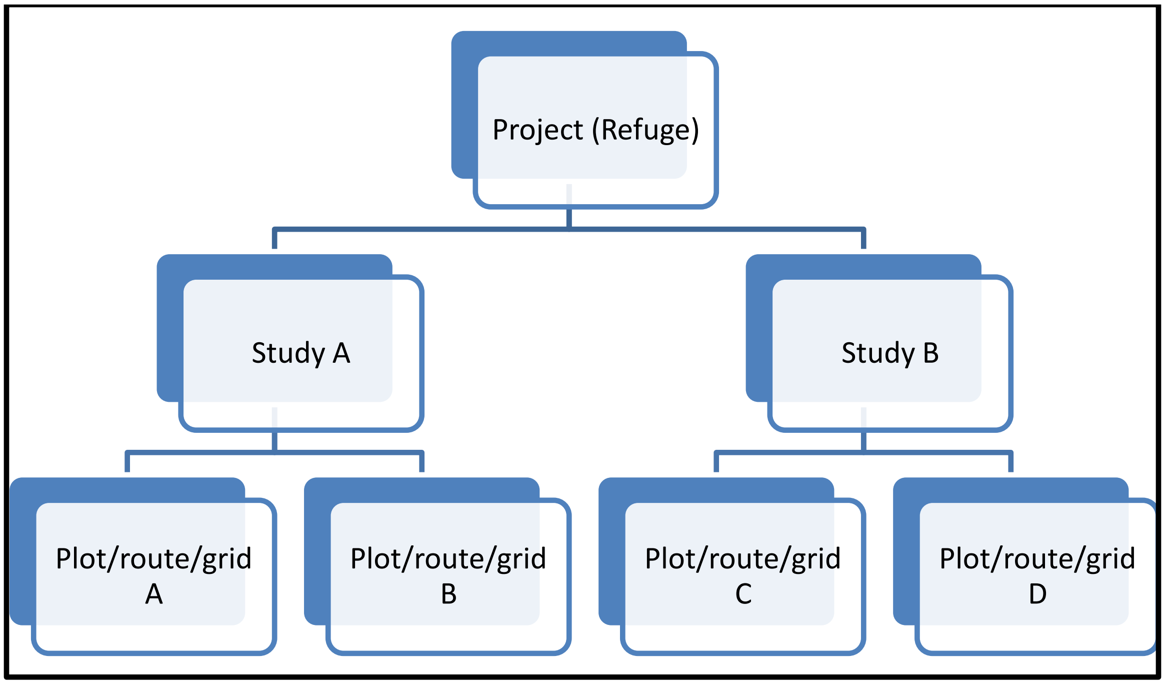

Figure SOP-5.1. Hierarchy of names for two studies on the same Project (refuge), with only 2 management units in each. A plot/route/grid may be a management unit or part of a management unit.

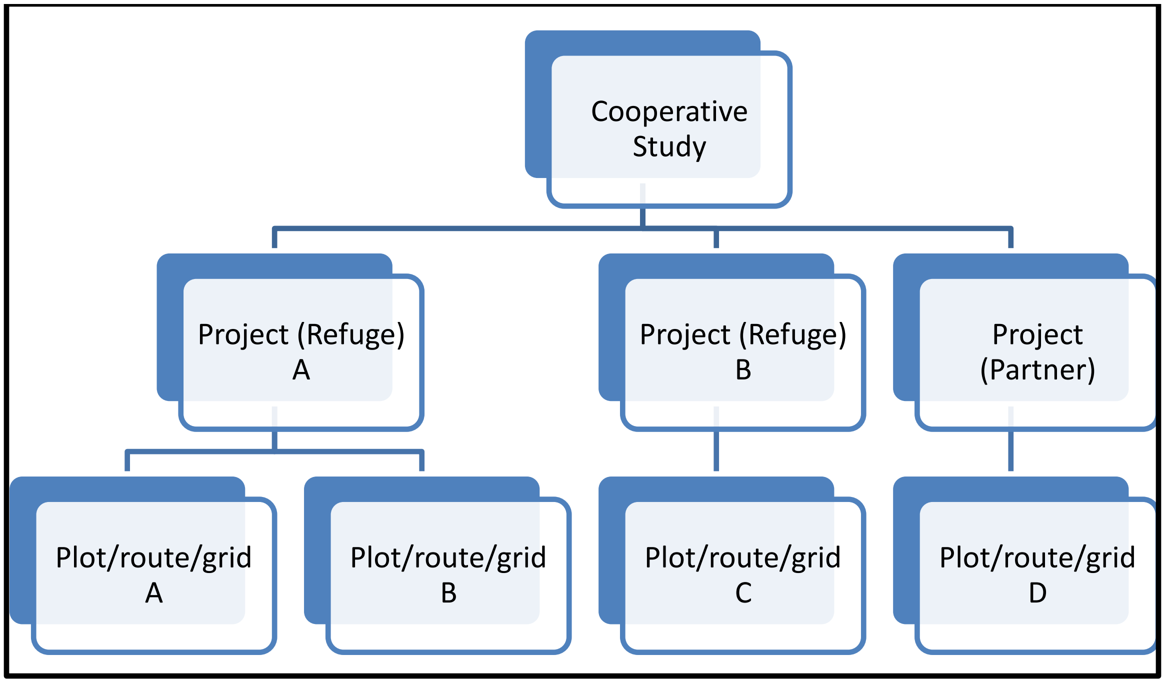

Figure SOP-5.2. A cooperative study may include multiple Projects (refuges or Partner agencies). Currently, the AKN database does not recognize this higher level organization (cooperative studies). A work-around is for the cooperative study coordinator to be named as an AKN Project Leader for each participating Project; data sets from multiple Projects can be combined outside of AKN for analysis. A plot/route/grid may be a management unit or part of a management unit.

Prepare for data entry—Data entry should begin as soon as possible after the data are collected. Upon returning from the field, the AKN Biologist should make a copy of each original field data sheet using the double-sided copy feature of copying machines. Review each copied data sheet for clarity. The copied data sheets are used for data entry; it is important that the copied data sheets are readable.

Proof the data sheets—Proofread the copied datasheets, making sure that they are filled out completely. All data sheets should have been reviewed for completeness while in the field. However, some deficiencies in data may not be identified until all data sheets have been reviewed as a group.

Data entry errors influence the quality and utility of collected data. However, many of these types of errors can be controlled through data organization, checking and entry techniques. The following steps should be used to reduce errors in the data base and make original data recording materials available for future reference, back-up or checking.

1. Organize data sheets by survey unit. Review the data sheets, ensuring that they have been filled out completely. If more than one person is collecting data, have someone that did not collect the data conduct the review.
2. Mark corrections on copied data sheets with a red pen. Any corrected errors, or changes made by the data "proofer" (that are entered differently into the database than they appear on the data sheet) should be circled, initialed, and corrected. Notes should be written in the margins or in the comments section to document the reason for the corrections.

Enter the data into the database and verify accuracy—

Prepare for data entry:

1. The AKN Biologist will organize the data and guidance materials to facilitate the data entry process.
2. A blank data sheet will help verify that you have all the right data entry fields for your project.
3. Have available the SSP and the name and contact information for the AKN Project Leader (survey coordinator), should questions arise.

Enter the data into the AKN database:

1. The AKN Biologist will navigate to the database interface (Midwest Avian Data Center) and log in to the Project's data entry site using your email address and password.
2. Enter all bird and habitat information from the datasheet into the database. When a data record is entered and saved, the status of the record is "RAW". This means it has not been proofed, i.e. checked for accuracy.
3. At points where no birds were detected note that "no birds were detected" in the comments section of the data entry screen to clarify that the point was in fact sampled.
4. After data have been entered, the technician will initial and date the "Data Entered" line at the top of that sheet.
5. After all data from each data sheet have been entered or uploaded, proof the data in the database, reviewing the data forms to check for typos, errors, and blank fields. As each data sheet (or any PDA output) is proofed, date and initial the datasheet to indicate that the entered data were reviewed and checked against the original data records. The AKN Biologist will also verify that the data have been proofed in the database by changing the status of the data records to "CLEAN" (see the user's manual for the database).
6. An additional, optional step is to have a different person proof a subset of the data. If errors are found, the status goes back to "RAW" while errors are being corrected.
7. The AKN Project Leader (survey coordinator) can run several reports available on the AKN database. Errors can often be detected by examining these reports (species not found in the study area, unusually high or low counts, etc.)

*Set the sharing level—*In general, AKN uses a tiered set of levels for indicating the status of data and sharing levels (Table SOP-5.1). Once the AKN Biologist is finished, he or she needs to notify the AKN Project Leader (survey coordinator) that the data are ready to be proofed in the database. The AKN Project Leader (survey coordinator) will:

1. Ensure all datasheets have been initialed.
2. Compare the data sheets with the data records in the database and if there are no errors, then change the status of the records to "APPROVED" (see the user's manual for the database).
3. If errors are found, discuss any questionable data entry or field observer errors with the AKN Biologist. If there are errors, the AKN Project Leader (survey coordinator) will change the status of the record back to "RAW".
4. After all errors are satisfactorily resolved in the database, the AKN Project Leader (survey coordinator) will change the status of the records in the database to "APPROVED".

5. The AKN Project Leader (survey coordinator) will then designate an appropriate data sharing level for approved data (Table SOP-5.1). Data collected by federal agencies or with federal funding should be set at Sharing Level 5.

Table SOP-5.1. The following are the Avian Knowledge Network's data access levels [1].

Data Access Codes	Definition and Description
Raw	Data were input but no further review or processing has taken place. Data are available for project use only and not to the AKN.
Clean	Data were input and reviewed by member(s) of the project team. Data are available for project use only and not to the AKN.
Approved	Data were reviewed by project management, but no indication has been made of AKN data sharing levels. Data are available for project use only and not to the AKN.
Restricted	Same as APPROVED and not distributed and shared to other AKN partners automatically. All access to data must come through requests to the contributing institution project management.
Level 1	Some information is made available to others than project members about the data. Specifically, only metadata about the datasets are made available to any application or service.
Level 2	Same as Level 1 with the following addition: data can be used in certain publicly available, predefined visualizations (i.e. maps and graphs), but direct access to the data is restricted.
Level 3	Data are used in publicly available, predefined visualizations (i.e. maps and graphs). Additionally, the complete Bird Monitoring Data Exchange (BMDE) data set is available upon request, subject to approval from the original data provider.
Level 4	Data can be used in publicly available, predefined visualizations (i.e. maps and graphs) and also may be available upon request. Additionally, some components of the data are made available to existing bioinformatic efforts (GBIF and ORNIS). These bioinformatic efforts only provide the data used to describe primary occurrence (e.g., location, date and species).
Level 5	Data are used in publicly available, predefined visualizations (i.e. maps and graphs) and are available to existing bioinformatic efforts. Additionally, the complete BMDE data set is available for download directly via download tools.

[1] These are applicable to each and every record in the network individually, so that different records may have different access levels. Data published using one of the five Levels are stored in the AKN's primary data warehouses. The warehouses serve as the primary archives of all AKN data. No applications connect directly to the warehouses, but data from a warehouse are ported to separate data views created specifically to optimize the performance of an application that connects to it. Data owners can specify how their data can be used in the data views, with the option that their data are not exposed to the public at all.

Database backup and editing—AKN is responsible for performing periodic backups of all data residing in the database. Only the AKN Project Leader (survey coordinator) can edit data that has already been approved in the database. NWRS staff should contact their regional database manager for assistance if numerous edits are needed. Changes to approved records must be documented in a log and stored along with the archived datasets in ServCat.

Data Security and Archiving

The AKN Project Leader (survey coordinator) will archive raw survey data, field notes, and photographs in compliance with relevant Service data standards (http://www.fws.gov/stand/) and pursuant to the Inventory and Monitoring Policy (701 FW2). The ServCat document library provides a long-term repository for all USFWS documents and data sets associated with a survey.

1. The archiving methods and locations of original data sheets and digital information should be specified in the SSP.
2. Scan the data sheets to create a digital archive. If a portable computer or personal digital assistant (PDA) is used, export the file as a csv file and archive to an appropriate digital storage location.
3. Archive the scanned data sheets or exported PDA file, along with survey reports and other digital survey files, in ServCat. In ServCat there is a 'Project' reference type that will allow multiple files to be linked to it; this is recommended to keep multiple reports, data sets, photos, and other files for a survey together. The original hard copy data forms should be stored on site in a safe place, preferably in a designated fireproof safe or cabinet.
4. Archive the vegetation photographs taken at each sampling point as well as any other photographs. Edit the digital images so that the station, plot, point, and date are affixed permanently to the photos associated with that point (bottom left corner of the photo). Digital photographs for each site, clearly labelled with the date, location, and other identifying information, can also be archived in ServCat.
5. Archive the GIS maps used to select the sample points and the GAP maps used to assign the land cover and ecosystem classes, along with other survey materials, in ServCat. This will allow for post-hoc analysis of attributes such as point count distances to edges, level of fragmentation, size of patches, etc., that may prove useful.
6. Archive any field specimens determined to have archival value on the station in appropriately designed facilities, or transfer them to authorized collection facilities such as museums or universities, following any permit requirements.

Protocol Revisions

Over time, revisions to Protocol Framework are to be expected. Careful documentation of changes to the protocol, and a library of previous protocol versions are needed to maintain consistency in data collection, and for appropriate treatment of the data during analysis. The Revision History Log explains the changes and assigns a new Version Number. All versions of the Protocol Framework will be archived together in ServCat, clearly designating which version of the Protocol Framework is current.

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Supplemental Materials

SM 1: Background Information from Version 1.0 of Protocol, Knutson et al. (2008)

The need for a standardized protocol for monitoring breeding landbirds was identified by the FWS, National Wildlife Refuge System (NWRS) during the Fulfilling the Promises initiative (U.S. Fish and Wildlife Service 1999). This initiative was prompted by new legislation, the National Wildlife Refuge Improvement Act (U.S. Congress 1997; Gergely et al. 2000), that broadened the mission of the Refuge System. The Promises Inventory and Monitoring Database Team (WH 9.1) reported that landbird monitoring on refuge stations was a high priority, ranking second in importance after waterfowl data (Kilbride et al. 2004).

Prior to 2008, most refuge stations, parks, and state agencies in the Midwest and Northeast were using one of two standardized protocols (Pence 1996; Howe et al. 1997). Our purpose in writing Version 1.0 was to promote the use of compatible field sampling methods among land managers in the Midwest and Northeastern U.S. and facilitate interagency habitat conservation and monitoring in the future. Version 1.0 of the protocol addressed the need to collect data in a manner that supported estimation of detection probabilities (Yoccoz et al. 2001). In addition, we addressed sampling design considerations and suggested sampling designs suitable for different management objectives.

The Version 1.0 protocol development was led by a team of FWS staff in cooperation with the National Park Service, Great Lakes Network and Northeast Temperate Network, and the Northeast Coordinated Bird Monitoring project. These National Park Service Networks subsequently adopted monitoring protocols with the same field methods. Version 1.0 of the protocol evolved from a passerine monitoring protocol used by the National Park Service, U.S. Geological Survey, and other agencies in Alaska since 2004. Version 1.0 followed the format in use at the time by the National Park Service Vital Signs Program.

The NWRS established a work group in 2005, with representatives from Regions 3, 4, and 5; their task was to develop a requirements analysis, review existing landbird monitoring protocols, and recommend or modify a protocol for use on National Wildlife Refuges (see Acknowledgements). In March of 2006 this work group conducted a survey of field stations in Regions 3 and 5 to help clarify the need and rank management objectives for monitoring landbirds (M. Knutson, *unpublished data*). Nearly 70% of the 98 stations that completed the survey collected landbird data during 2003-2005; 65% of stations reported that they planned to collect landbird data during 2006-2009. The most common habitats surveyed for landbirds were forests, grasslands, shrublands, and marsh. Fifty-six percent of the stations indicated they would welcome some guidance regarding landbird monitoring and help with data management and analysis. The stations ranked their objectives (from high to low) for monitoring landbirds:

1. Baseline inventory (44% of stations identified this as their highest priority).
2. Evaluation of management actions, local scale.
3. Detecting trends, local scale.
4. Evaluation of management actions, ecoregion or regional scale.
5. Detecting trends, regional scale.

6. Testing assumptions underlying biological models.
7. Detecting trends, national scale.

Rationale for Key Elements of the Protocol Methods

The following table (Table SM-2.1) outlines the rationale used to decide specific aspects of the bird count methods. Several conference calls were held with leading ornithologists and statisticians to review and discuss these elements when Version 1.0 of the protocol was developed. The protocol represents the outcome of these discussions.

Table SM-1.1. Key elements of the landbird monitoring protocol with rationale. Note: this section is included as historical information that shaped Version 1.0 of the protocol. Some elements are no longer relevant to the current version of the protocol and have not been updated.

Element	Strategy	Rationale
Observation time	10 min., recording a bird the *first* time it is observed, within one-minute time intervals. The count period is divided into ten, 1-min. time intervals. As birds are detected in one time interval, they are considered "removed" from the population of birds being sampled in subsequent intervals.	One-minute intervals will allow application of the time-removal method for estimating detection probabilities. Field testing indicates that logistics are relatively simple. One min. intervals allow comparison with the BBS (3 min) and legacy data (5 or 10 min.). However, the time-removal method is more sensitive to violations of the assumptions than are distance methods. It is important to avoid double-counting when birds move. Training is important to avoid double-counting. Several other federal & state bird monitoring programs in the Midwest & Northeast use 10 min. listening times. Ten min. will minimize missing bird species that are rare or sing or call infrequently. This is admittedly a tradeoff with the risk of double-counting. References: (Ralph et al. 1993; Farnsworth et al. 2002; Moore et al. 2004; Faccio and Mitchell 2007)
Distance estimation	Forest & grasslands: 0–25m, 26–50m, 51–100m, > 100m In dense (shrub) habitats: 0–25m, 26–50m, > 50m	Distance bands will be used to define an area for estimates of relative abundance or density, not for purposes of estimating detection probability. Recent research and observer reports indicate that distance estimates are unlikely to be accurate when birds are often heard but not seen. These bands are frequently used in multi-species monitoring and will allow comparisons with other data sets. Field observers still need training in distance estimation to accurately place observations within these broad distance bands. A range-finder is recommended for use in training and for daily use. References: (Verner 1988; Farnsworth et al. 2005; Alldredge et al. 2007; Simons et al. 2007)
Bird attributes	Identify birds to species and record if the detection was visual, auditory, or both. Record flyovers separately.	Simplifying the protocol will allow observers to concentrate on detecting all species, the primary objective. Recording visual vs. auditory detections will allow exploration of bias during the analysis. Flyovers may not be breeding in the count circle, but we still want to record the presence of all species; this also adds flexibility during analysis. Depending upon the species, a bird may or may not be using the point circle as breeding habitat. We clarify the definition of a flyover in SOP 3, Conducting the Point Count. References: (Ralph et al. 1993; Johnson 2008)
One observer	One bird observer is	Requiring two trained bird observers to visit all sampling sites as

	recommended. A field companion to record may increase efficiency and personal safety.	a team is a financial and logistical obstacle for most stations. There are additional training requirements for the double-observer method. If two trained observers are available, the preference is to maximize the number of point surveyed rather than having them survey in pairs. References: (Nichols et al. 2000; Pollock et al. 2002; Farnsworth et al. 2005)
Distance between points	300 m	If birds are observed at distances > 100 m, a minimum distance of 300 m is needed between points to avoid double-counting individuals. If the sampling frame is large, increasing the distance between points is recommended (400 m). In shrublands or other dense habitats in which birds are only detected within 25 or 50 m, shorter distances between points are possible. These situations will be assessed individually and adjustments made. References: (Verner 1988; Ralph et al. 1993)
Sampling design	Probabilistic sampling design, tailored to specific objectives	Several probabilistic sampling designs for local point count sampling are defined in the protocol. Please avoid non-probabilistic (convenience or ad hoc) sampling designs. Simple random or stratified random sampling designs are appropriate for local (station) scale designs. If a landscape-scale sampling design for point counts is needed, Generalized Random Tessellation Stratified Design (GRTS) has been used successfully by EPA and the Park Service. References: (Stevens and Olsen 2004; Lister and Scott 2009)
Repeat visits	Minimum: 1 visit Optional: 3 or more visits to a survey point per season.	Management objectives must be defined before making decisions about repeat visits. Decisions about repeat visits are linked to decisions about sampling design & number of sample locations. One visit is the minimum requirement. Use one visit if you want to maximize the total number of survey points visited, if access is difficult or time-consuming, or if you cannot obtain sufficient resources for multiple visits. A minimum of three visits per point within a season will allow modeling of habitat associations using an occupancy approach for some species and will address another aspect of detection - availability. It will also increase the likelihood that at least one survey was conducted during the peak of detection for most species. Use three or more visits if you have a small area to survey and want to increase precision, access is simple, or if you plan to use occupancy to model habitat associations. Three visits are estimated to be the minimum number needed when detection probability is > 0.5; more visits are needed when detection probability is lower. References: (MacKenzie and Royle 2005; MacKenzie et al. 2006; Bailey et al. 2007)
Habitat monitoring	Required: Location (UTM or Geographic coordinates) General habitat type (NLCD class)	The issue here is: what is the minimum requirement for collecting habitat information that will be permanently linked to each bird observation in the National Bird Point Count Database? Most habitat variables will be designed to address specific objectives of the monitoring effort at a station. However, some minimum habitat information should be linked to the bird

	Optional, depending upon Objectives: *Digital photograph of site *Plant community type (Ecological System - NatureServe) *Dominant plant species Plant structure (height, density, etc.) *Landscape context *Ecosystem integrity (degradation, invasive species, etc.)	data for purposes of locating the sampling point in space and filtering the data by habitat type. The specific geographic location is needed to link the bird data to digital maps of habitat, elevation, soil characteristics, and landscape context. The general habitat type will be needed for future uses of the data beyond the immediate need. The NLCD (2001) classes are a simple standardized classification of general vegetation types and include all types of land uses, including agriculture. Not all stations currently have Ecological System information; this will be an optional field in the national database. A digital ground photograph of the site is quick, easy, cheap, and captures information that may prove useful in the future. Aerial photos are routinely used to assess ecological problems. Ground photographs have proven useful for a variety of ecological issues: glacial retreat, integrity of steams, forest fuel loading, forest succession, etc. The task of defining a standard set of core habitat metrics for different habitat types could be addressed by a national PIF work group.

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SM 2: Equipment and Supplies

NUMBER REQUIRED	ITEM DESCRIPTION
	Waterproof binoculars (10 x 40)
	Compasses
	Celsius (0-50 degrees) Thermometers
	Handheld laser rangefinders (10-200+ meter range)
	Handheld GPS units for navigation. See Garmin© website for current models of one brand.
	Sound level (decibel) meter (optional)
	Bird Field Guides (one for each field observer) [1]
	Rite-In-the-Rain© spiral field notebooks
	Field Data Sheets (printed on waterproof paper)
	Clipboards (recommended: metal with storage area)
	Laminated grid maps with waypoint coordinates list on back of map.
	Topographic or other maps
	Digital camera, GPS recording feature and extra batteries and storage cards
	Software for handheld device that features bird photos and audio
	Radio or phone system for field to base & field to field communications
	First aid kits
	Extra batteries (for radios, GPS, rangefinders, etc.)
	Rolls of flagging (for marking points, gear that might be lost, etc.)
	Canisters of bear spray, if needed
	Digital timer with clip (example: http://www.indoorhealthproducts.com/100ms.htm)
	Rubber mallet (for marking sample locations)
	Survey markers (for marking sample locations)
	Permanent sampling point marker caps stamped with point numbers
	Measuring tapes

[1] Purchase any of the major bird field guides that cover your survey region for each field observer. There are many excellent guides to choose from.

SM 3: Example of Bird Species List with AOU Codes

AOU SPECIES CODE	COMMON NAME	GENUS SPECIES	TSN
GWFG	Greater White-fronted Goose	*Anser albifrons*	175020
CANG	Canada Goose	*Branta canadensis*	174999
TRUS	Trumpeter Swan	*Cygnus buccinator*	174992
GADW	Gadwall	*Anas strepera*	175073
AMWI	American Wigeon	*Anas americana*	175094
MALL	Mallard	*Anas platyrhynchos*	175063
CITE	Cinnamon Teal	*Anas cyanoptera*	175089
NSHO	Northern Shoveler	*Anas clypeata*	175096
NOPI	Northern Pintail	*Anas acuta*	175074
AGWT	American Green Winged Teal	*Anas crecca*	175081
CANV	Canvasback	*Aythya valisineria*	175129
REDH	Redhead	*Aythya americana*	175125
RNDU	Ring-necked Duck	*Aythya collaris*	175128
GRSC	Greater Scaup	*Aythya marila*	175130
LESC	Lesser Scaup	*Aythya affinis*	175134
SCSP	Scaup Sp.	*Aythya sp.*	
SUSC	Surf Scoter	*Melanitta perspicillata*	175170
BLSC	Black Scoter	*Melanitta nigra*	175171
WWSC	White-winged Scoter	*Melanitta fusca*	175163

SM 4: Bird and Habitat Survey Form

This is a two sided form with a reference sheet.

Highlighted fields are pre-filled on the data sheets by the survey coordinator.

Project (NWR/WMD):________________________________Study Name: ____

Data Entered into the AKN database, Date________ by (initials) _______ Data Proofed on AKN database, Date_______ by (initials) ________

SURVEY INFORMATION

Observer(s):	Date of Survey:
Recorder (if any):	Visit Number:
	Start Time:

Point Name:

Location (plot/route/grid):

Datum: WGS84

Lat:

Long:

Vegetation Protocol Conducted? Y / N (circle)

Photos taken? Y / N (circle)

VEGETATION CLASSIFICATION

GAP Macrogroup: Verified (Y or N)

GAP Ecological System (Primary): Verified (Y or N)

(If Ecological System is not correct, circle the correct system on the reverse)

Is within 100 m of edge? Y or N If Y, circle secondary ES on the reverse.

SITE CONDITIONS

Disturbance (from list on reverse):

Noise:

Temperature: Celsius

Wind Speed:

Wind Direction:

Sky Code:

Tide Code:

DETECTION CODE KEY

Distance Band		Detection Type	
25	0 – 25m	A	Audio, heard
50	26 – 50m	V	Visual, seen
100	51 – 100m	B	Both, heard & seen
> 100	> 100m	FLY	Flyover, above canopy

Comments. Document problems or unusual observations, including incorrect ecosystem classes assigned to the point.

Highlighted fields are pre-filled on the data sheets by the survey coordinator.

BIRD DETECTIONS

Obs #	Species AOU code	Min. (0,1,2,..9)	# of birds	Distance band	Obs. Type (A, V, B)	FLY # birds	Note
1							
2							
3							
5							
6							
7							
8							
9							
10							
11							
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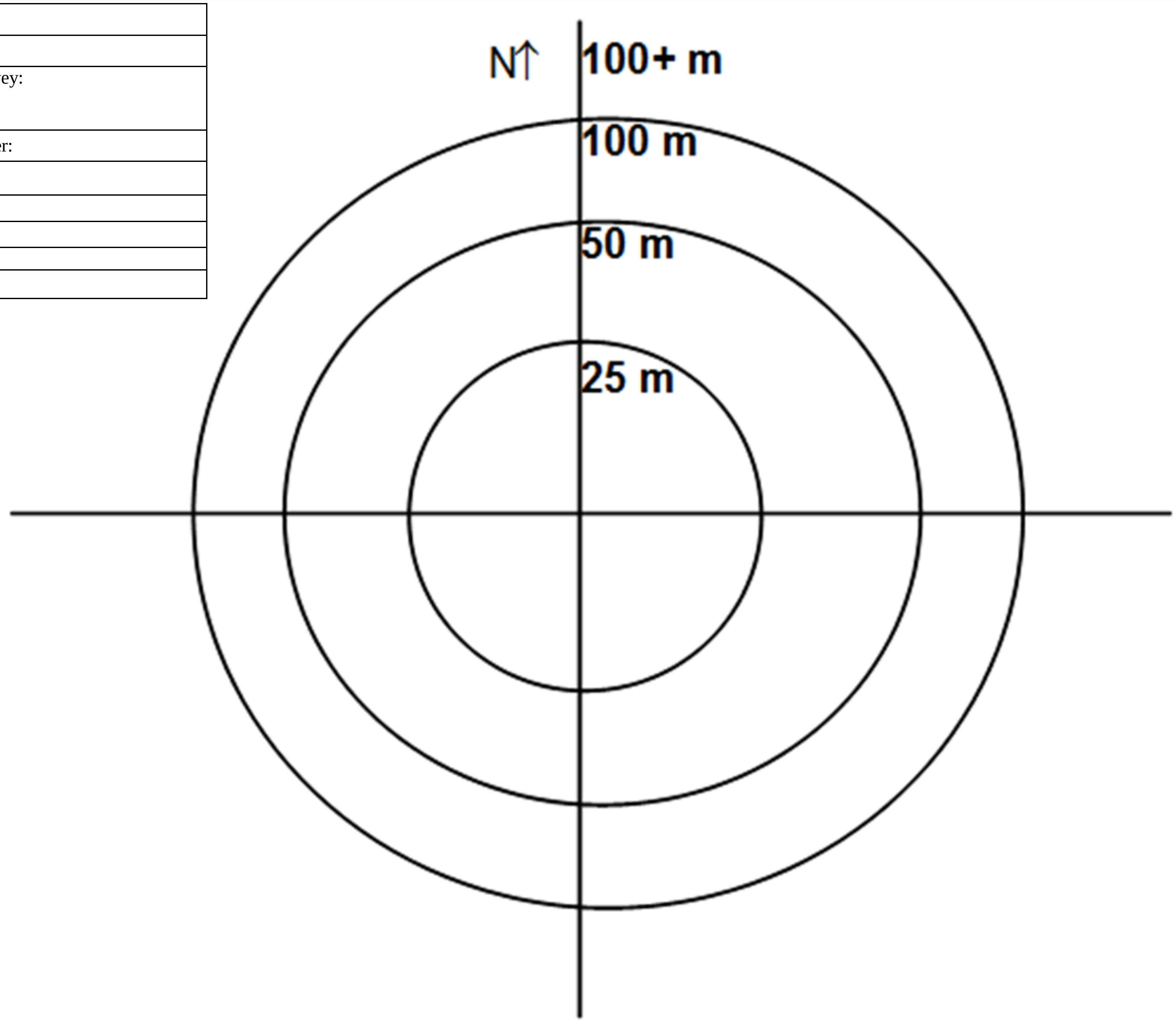
37							
38							
39							
40							
41							

Bird and Habitat Survey Form - Circular Plot (Back)

Project (NWR/WMD):________________________________Study Name: ____
Data Entered into the AKN database, Date________ by (initials) _______ Data Proofed on AKN database, Date_______ by (initials) ________

SURVEY INFORMATION	
Observer(s):	Date of Survey:
Recorder (if any):	Visit Number:
	Start Time:
Point Name:	
Location (plot/route/grid):	
Datum: WGS84	
Lat:	Long:



Bird and Habitat Survey Form-Reference Page

SITE CONDITION CODE KEY		
Noise	**Sky Code**	**Possible Ecological Systems**
0 = None	0 = Clear, few clouds	[survey coordinator fills in all possible ecological systems that may be encountered at survey points]
1 = Faint	1 = Partly cloudy, scattered	
2 = Moderate	2 = Cloudy (broken), Overcast	
3 = Loud	3 = Sand/Dust storm	
4 = Intense; 9=Not Recorded	4 = Fog or Smoke	
	5 = Drizzle	
Wind Speed (Beaufort Scale)	6 = Snow	
0 (< 1mph) = Calm	7 = Snow/Sleet	
1 (1 – 3 mph) = Light air	8 = Showers	
2 (4 – 7 mph) = Light breeze	9 = Not Recorded	
3 (8 – 12 mph) = Gentle breeze		
4 (13 – 18 mph) = Moderate breeze	**Tide Code**	**Disturbances (circle no more than 5)**
5 (19 – 24 mph) = Fresh breeze	1 = High	Animal damage; Invaded by exotic species; Chained;
6 (25 – 31 mph) = Strong breeze	2 = Almost high and rising	Mowed; Construction – building; road; trail
7 (32 – 46 mph) = Moderate gale	3 = Almost high and falling	Plowed/disked; Prescribed burn; Treated with fertilizer;
8 = Other (make note)	4 = Half tide, rising	Drought damage; Treated with insecticide;
9 = Not Recorded	5 = Half tide, falling	Flooded wetland (drained); Forest (clear-cut);
	6 = Almost low, rising	Forest (selective harvest); Wetland (fall drawdown);
Wind Direction	7 = Almost low, falling	Wetland (spring drawdown); Grazed; Wildfire; Hurricane;
N, NE, E, SE,	8 = Low	Wind event/blowdown; Ice damage; Insect damage
S, SW, W, NW	9 = Not Observed, not applicable, or observations made during more than one of these periods	Other: write in
VRB = variable		No disturbance

SM 5: The Project Record

The project record is an administrative record of the survey and is a critical documentation and communication vehicle, especially for surveys with multiple people involved or one that will span several years. The project record maintains key information (metadata) about an ongoing survey in a relatively condensed format and is maintained and regularly updated, usually by the survey coordinator. It serves as a 'living document' that changes as the survey evolves, summarizing key information from survey documents such as meeting notes, workshops, conference call minutes, protocols, survey designs, fact sheets, lists of participants, survey data, reports, etc. The project record helps all survey cooperators to recall key decisions, due dates, action items, and information about complex surveys. It also serves to orient new staff joining the survey. Finally, the project record provides a quick reference when preparing reports and journal papers. The project record should be archived and periodically updated in ServCat, along with the site specific survey protocol (SSP), other written materials, maps, and data.

Suggested Outline

1. Project title;
2. Brief summary of survey purpose;
3. Project coordinator's contact information;
4. Current status (action items, projected timeline, long-term plans);
5. Key elements (problem, objectives, alternatives);
6. Model descriptions;
7. Data management plan and sharing agreements;
8. Data analysis plan and reporting schedule;
9. Communication plan;
10. Who's involved (stakeholders, cooperators);
11. Log of meetings and conference calls, with synopsis and dates of key decisions;
12. A list of written materials and where they are archived (protocols, maps, communication plan, reports, presentations, fact sheets, training materials);
13. Budget;
14. References;
15. Appendices.

SM 6: Common Noise Levels

The decibel levels of common sounds are provided below to aide in identifying the correct category of sound to record on the datasheet (SOP 3, SM 4).

Decibels of Common Sounds

0 the softest sound a person can hear with normal hearing
10 normal breathing
20 whispering at 5 feet
30 soft whisper
50 rainfall
60 normal conversation
110 shouting in ear
120 thunder

Table SM-6.1. Decibel levels for common activities.

HOME	WORK	RECREATION
50 refrigerator	40 quiet office, library	40 quiet residential area
50 - 60 electric toothbrush	50 large office	70 freeway traffic
50 - 75 washing machine	65 - 95 power lawn mower	85 heavy traffic, noisy restaurant
50 - 75 air conditioner	80 manual machine, tools	90 truck, shouted conversation
50 - 80 electric shaver	85 handsaw	95 - 110 motorcycle
55 coffee percolator	90 tractor	100 snowmobile
55 - 70 dishwasher	90 - 115 subway	100 school dance, boom box
60 sewing machine	95 electric drill	110 disco
60 - 85 vacuum cleaner	100 factory machinery	110 busy video arcade
60 - 95 hair dryer	100 woodworking class	110 symphony concert
65 - 80 alarm clock	105 snow blower	110 car horn
70 TV audio	110 power saw	110 -120 rock concert
70 - 80 coffee grinder	110 leafblower	112 personal cassette player on high
70 - 95 garbage disposal	120 chain saw, hammer on nail	117 football game (stadium)
75 - 85 flush toilet	120 pneumatic drills, heavy machine	120 band concert
80 pop-up toaster	120 jet plane (at ramp)	125 auto stereo (factory installed)
80 doorbell	120 ambulance siren	130 stock car races
80 ringing telephone	125 chain saw	143 bicycle horn
80 whistling kettle	130 jackhammer, power drill	150 firecracker
80 - 90 food mixer or processor	130 air raid	156 capgun
80 - 90 blender	130 percussion section at symphony	157 balloon pop
80 - 95 garbage disposal	140 airplane taking off	162 fireworks (at 3 feet)
110 baby crying	150 jet engine taking off	163 rifle
110 squeaky toy held close to the ear	150 artillery fire at 500 feet	166 handgun
135 noisy squeeze toys	180 rocket launching from pad	170 shotgun

SM 7: Glossary

Accuracy. Measures precision and bias of estimators. A sample-based estimator is considered accurate when multiple sampling trials give a very similar answer that on average is the same as the true value for the parameter of interest (Williams et al. 2002).

Adaptive management. A structured process that promotes flexible, informed decisions that allow us to make adjustments as we better understand outcomes from management actions and other events. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process (Williams et al. 2012).

AKN. The Avian Knowledge Network (AKN) hosts the central database for this protocol. AKN is a partnership of organizations that seeks to improve the conservation of birds and their habitats by hosting a central data warehouse and seeking to improve the quality and long-term value of bird data. The AKN has special terms:

- Project: In the AKN, projects are defined around data access and data ownership. AKN Projects are the fundamental atomic unit of data ownership and all registered members of a project have access to (i.e., can add, delete, edit & download) data from the project.

- You may join an AKN project under one of four roles: Project Leader, Analyst, Biologist and Citizen Scientist. The first three roles are described below. The latter, Citizen Scientists, is a reserved role for non-professionals to enter data for specific project.

- AKN Project Leader: Each project in the AKN must have at least one Project Leader (survey coordinator). The three responsibilities of AKN Project Leaders are to review, publish, and share (see AKN data access levels below) data from the project, to grant/revoke others' access request to the project, and to review and grant/revoke data requests from third parties. AKN Project Leaders can download all the data and metadata about the project, including geospatial data for sampling units, researcher names associated with the project, and all the observational data, among other things. AKN Project Leaders may allow others to join their projects as additional AKN Project Leaders and they can review who else has access to a project.

- AKN Biologist: An AKN Biologist is a person who enters, edits, and proofs data. He or she is often the person collecting the field data, or just transcribing from field notes. Biologists can download event and observation data, usually for proofing purposes.

- AKN Analyst: AKN Analysts are persons granted the use of the Analyst tool to generate simple summaries and visualizations of the data. Analysts can also download warehouse data (i.e., a much simplified and filtered table of the data used for the visualizations).

Attribute. A feature or process of the environment that can be measured or estimated and that provides insights into the state of a resource or related ecological indicator (Elzinga et al. 2001). Attributes are often employed as covariates in data analyses.

Bias. The difference between the expected value of an estimator and the parameter it is meant to estimate. Biased statistics either overestimate or underestimate the true value.

Ecological systems. See Vegetation Classes.

Detectability. The conditional probability that an individual from a population will be observed or captured on a sampling unit, given that the species is present (Vesely et al. 2006).

Inventory. A survey that estimates the presence, abundance, or distribution of species, habitats, ecological communities, or abiotic features at a particular time.
Inventory and Monitoring Plan. A plan required by Service policy (701 FW 2) documenting the surveys that a refuge selects to implement.

Metadata. Description of the content, quality, history, condition, and other characteristics of recorded information. Federal agencies must create metadata that meets specific standards for newly collected or produced geospatial and biological data (see Executive Order 12906 as amended by Executive Order 13286, Federal Geographic Data Committee 2000).

Monitoring. A survey repeated through time to document changes in select attributes of wildlife, plants, habitats, ecological communities, or abiotic resources (701 FW 2.6). Two types of monitoring referred to in this handbook are:

- Baseline Monitoring. Monitoring that is not tied to specific predictions of how a natural resource will respond to management or environmental stressors, but instead is designed to document change over time of a natural resource. Also referred to as surveillance monitoring, examples include monitoring climatic parameters, species population trends over time, disease incidence, contaminants, and wilderness character.
- Monitoring to Inform Management. Monitoring to assess whether a natural resource is approaching or exceeding a defined threshold or if a resource is responding to management action or system stressor in a specified manner. This type of monitoring involves defining the threshold values or expected response, then surveying to measure the response or a closely related indicator. Comparing monitoring results with these expected values may indicate the need for initiating, intensifying, or altering management actions. In the I&M policy and this handbook, it generally means monitoring in an adaptive management context to improve management or evaluate progress toward achieving management objectives. Also referred to as targeted monitoring.

Objective, management. A concise statement of desired outcomes that specifies what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for achieving it.

Objective, sampling. Specifies target levels of accuracy required to reliably interpret the data collected in a survey. These targets determine the level of rigor needed to meet the objectives.

Parameter. A summary value for a variable measured on the sampling units in the sample frame. Examples include the population mean and variance.

Population, target. The set of individuals or species that are the focus of inquiry in a survey.

Power (statistical). The probability of detecting an effect given that there is an effect of specified magnitude. Power calculations require specifying sample size, variability in the data, the specific statistical test, the alpha level, as well as the magnitude of the assumed true effect.

Precision. Variability of measurements within or among samples. The standard error and the coefficient of variation often are used to quantify precision of a parameter. Precision contrasts with bias, which focuses on how the average sample estimate differs from the true value.

Protocol. Detailed instructions for conducting a survey. This includes information on sampling procedures, data collection, management and analysis, and reporting of results. In this handbook the term protocol refers to either a survey protocol framework or a site-specific survey protocol (701 FW 2.6).

- Survey protocol framework. A survey protocol that was written for application at many locations, but lacks the site-specific information necessary to implement the protocol at an individual refuge.
- Site-specific survey protocol (SSP). A complete set of instructions used to conduct a survey at a specific refuge. We typically develop these by adding site-specific instructions to a generalized protocol framework or by modifying a site-specific protocol that was developed for a similar survey at another refuge.

PRIMR. A database for Planning and Review of Inventory and Monitoring at Refuges (PRIMR). This database describes and archives the surveys conducted on the refuges, and can be a tool to generate summaries for an Inventory and Monitoring Plan.

Regional Data Manager. The NWRS has regional data managers to assist refuge stations with data management. These staff can assist refuge stations to set up their surveys for data entry into in the AKN.

Rigor. The standard of quality in the effort invested to obtain results. Survey rigor is derived from the level of effort, scientific and technical expertise, and intensity devoted to planning and gathering data.

Sample size. The number of units within the sample frame that are selected for sampling.

Sample frame. The collection of all possible sampling units from which the sample is selected; used to estimate the chance of selecting a sample unit. These units closely approximate the target population that is the focus of inquiry.

Sampling unit. The units that are selected for collecting data in survey; these units may include individual organisms, quadrats, transects or points on a map.

ServCat. The U.S. Fish and Wildlife Service document catalog is an online repository designed to centralize and preserve Service information. This includes reports, annual narratives, management plans, geospatial data, Inventory and Monitoring Plans and survey protocols.

Standard Operating Procedure (SOP). A written document or instruction detailing all relevant steps and activities of a process or procedure.

Refuge. Any unit of the National Wildlife Refuge System, including refuges, wetland management districts, and associated waterfowl production areas.

Survey. A specific data-collection effort to complete an inventory or conduct monitoring of biotic or abiotic resources (701 FW 2).

Survey Coordinator. A Service employee, usually the Refuge Biologist, who oversees the implementation of one or more surveys selected in an IMP. This includes selection of survey protocols that adhere to standards of scientific excellence. The survey coordinator also ensures that survey data are managed, analyzed and reported, and results are archived in ServCat. When surveys involve implementation by cooperators or partners, the survey coordinator ensures that the I&M policy requirements for surveys are met. (701 FW 2). The AKN database refers to this person as the “Project Leader”, the same term used by USFWS refuges for the refuge manager. Therefore, we use the term ‘survey coordinator’ throughout this protocol to avoid confusion.

Target Universe. The population about which you want to make an inference.

Uncertainty. The extent to which we cannot reliably predict the outcome or result of an action or event, or prove that something is true. In a monitoring context, it generally refers to the accuracy of conclusions drawn from survey data or models, or the correctness of our predictions as to how a species or habitat will respond to a management action. Sources of uncertainty about management effectiveness include ecological (structural) uncertainty, environmental variation, partial controllability, and partial observability (Nichols et al. 2011).

Vegetation Classes. Represent recurring groups of biological communities (ecological systems) that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. Several federal and NGO agencies collaborated to develop standardized and mapped vegetation classes; we employ the USGS GAP Analysis Land Cover Map.

Zone Biologist (I&M). A Refuge System staff member assigned to conduct I&M duties for a portion of refuges within a Region. This person (1) assists refuge staff to prepare IMPs, (2) participates in protocol assignment and development, and amending IMPs as new protocols are adopted, (3) assists Refuge System staff with managing and analyzing data and reporting survey results, and (4) provides scientific support to refuges within their Regions (701 FW 2).

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National Wildlife Refuge System