2015

Spring Creek Valley

Section 206 Aquatic Ecosystem Restoration

Appendix F – Monitoring & Adaptive Management Plan

Chicago District
US Army Corps of Engineers
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Table of Contents

Introduction

Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure, that when conducting a feasibility study for a project (or component of a project) under the Corps ecosystem restoration mission, that the recommended project includes a monitoring plan to measure the success of the ecosystem restoration and to dictate the direction adaptive management should proceed, if needed. This monitoring and adaptive management plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Secretary determines that the success criteria have been met.

Section 2039 of WRDA 2007 also directs the Corps to develop an adaptive management plan for all ecosystem restoration projects. The adaptive management plan must be appropriately scoped to the scale of the project. The information generated by the monitoring plan will be used by the District in consultation with the Federal and State resources agencies and the MSC to guide decisions on operational or structural changes that may be needed to ensure that the ecosystem restoration project meets the success criteria.

An effective monitoring program is necessary to assess the status and trends of ecological health and biota richness and abundance on a per project basis, as well as to report on regional program success within the United States. Assessing status and trends includes both spatial and temporal variations. Gathered information under this monitoring plan will provide insights into the effectiveness of current restoration projects and adaptive management strategies, and indicate where goals have been met, if actions should continue, and/or whether more aggressive management is warranted.

Monitoring the changes at a project site is not always a simple task. Ecosystems, by their very nature, are dynamic systems where populations of macroinvertebrates, fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult, and distinguishing the changes caused by human actions from natural variations can be even more difficult. This is why a focused monitoring protocol tied directly to the planning objectives needs to be followed.

This Monitoring and Adaptive Management Plan describes the existing habitats and monitoring methods that could be utilized to assess projects. By reporting on environmental changes, the results from this monitoring effort will be able to evaluate whether measurable results have been achieved and whether the intent of Section 206 Aquatic Ecosystem Restoration are being met.

Guidance

The following documents provide distinct Corps policy and guidance that are pertinent to developing this monitoring and adaptive management plan:

a. Section 2039 of WRDA 2007 Monitoring Ecosystem Restoration

    (a) In General - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.
    (b) Monitoring Plan - The monitoring plan shall--
        (1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and

(2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility.

b. USACE. 2009. Planning Memorandum. Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) - Monitoring Ecosystem Restoration

c. USACE. 2000. ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies. Washington D.C.

d. USACE. 2003a. ER 1105-2-404. Planning Civil Work Projects under the Environmental Operating Principles. Washington, D.C.

General Monitoring Objectives

As presented in “Guidance on Monitoring Ecosystem Restoration Project” on 12 January 2010, the following are general project monitoring objectives:

- To determine and prioritize needs for ecosystem restoration
- To support adaptive management of implemented projects
- To assess and justify adaptive management expenditures
- To minimize costs and maximize benefits of future restoration projects
- To determine “ecological success”, document, and communicate it
- To advance the state of ecosystem restoration practice

Project Area Description

The site lies 3 miles west of Barrington and one mile east of Carpentersville in the northwest corner of the county, adjacent to the small Chicago suburb of Barrington Hills. It includes parts of Sections 5, 6, 7, 8, 17, 18, 19, 20, 28, 29, 30, 31, and 32 of T42N, R9E. Spring Creek’s headwaters originate just east of the eastern boundary of the site near the southern boundary line of the project, and flow generally north though the project site into Lake County and eventually the Fox River.

Environmental Trends Triggering Restoration

Agriculture and urban development has had a major influence on the physical structure of habitat and the processes that created and sustained these habitats. This has allowed invasive and nonnative species to colonize these altered areas. There is also a negative feedback loop in some stream sections where altered hydrology and lack of fire has induced the riparian structure to fail, in turn causing the stream to unravel, which feeds back to more altered hydrology and hydraulics. Specific problems with primary ecosystem drivers include:

Restoration Design Overview

This project seeks to restore riverine and riparian corridor hydrology, hydraulics and, associated riparian floral and faunal diversity. Restoration measures include restoring natural groundwater and surface water hydrology to all areas that have been previously drained by permanently disabling the existing drain tile system. Restoring surface hydrology along the western portion of the Spring Creek Preserve by removing the side cast berms along the ditch allowing former wetland areas to become inundated. Invasive species removal will occur through herbicide applications and prescribed burns as well as seeding and planting within wetland, degraded prairie and savanna habitats, and riparian communities.

Monitoring Components

All monitoring components will continue to be refined and design and construction progresses. This version of the monitoring plan is based on feasibility level information.

Component 1 – Biological Response

These monitoring events would occur every other year during a 10-year monitoring period.

Plant Communities
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Background and Introduction
Many different protocols exist for monitoring vegetation within grasslands and prairies. Since each method provides somewhat different information, it is important to settle on a standard protocol that will be used throughout the duration of a project, so that data can be reliably compared over time. Using the same protocol across different projects provides the added ability to compare the effectiveness of restoration across sites and to use this information to inform restoration plans going forward.

The following monitoring recommendations draw upon more than 40 years of monitoring and adaptive management work that has been conducted by professional and volunteer experts within the Chicago Wilderness community. The protocol recommended here has been used by staff and volunteers with Audubon Chicago Region and the Habitat Project since 2001 (*e.g.* Glennemeier 2006). This method has produced results that accurately describe the quality of the vegetation community and are sensitive to changes in this quality over time, while requiring a reasonable investment of time and resources.

The most successful projects not only include a well-articulated monitoring and adaptive management plan, but also a plan for engaging partners and collaborators in project design, implementation, monitoring, management, and community engagement. While outside the scope of this document, these recommendations nonetheless are an important component of successful restoration projects within urban areas such as Chicago Wilderness.

Finally, while this document addresses only vegetation monitoring, it is important to consider any additional taxa that will be monitored, so that efforts can be coordinated. Placing vegetation transects within bird point count circles, for example, can allow conclusions to be drawn about the impact of vegetation changes on bird communities.

Monitoring Methods

The goals of the project and the resources available will determine what type of sampling is conducted. This protocol outlines standard methods for different project sizes, budgets, and goals, so that the appropriate quantitative monitoring method can be used for each project. A flowchart is provided at the end of this document (see p. 13), to help determine the best protocol for a given project.

An initial site visit is necessary before designing a quantitative monitoring program, so that the researcher may determine the heterogeneity – or the number of different habitat types – within the site, as well as the presence of any rare species that might warrant a special monitoring protocol. If a full species list is desired, practitioners walk the entire site and record all plant species found, without noting numbers or abundance. A species list provides a reliable measure of site quality and can help distinguish between remnants and restorations. Compiling a species list also is the best way to ensure that rare species are detected, because the entire site is covered.

During the initial site visit, where the quality of the vegetation community changes noticeably, or where known differences exist in site history or management, these different areas should be noted on a map. Each area will become its own "sample universe" or "area of interest" when designing quantitative monitoring. It is possible to note these important differences without compiling a full species list, if the latter is impractical due to limited resources or other constraints. Simply gauge the quality of the site overall and note differences that may be important for representative sampling.

Quantitative monitoring protocol

The primary unit of grassland monitoring is the quadrat. Studies have shown that a quadrat size of ¼ m^2 provides the best balance between time spent and accuracy of data collected (White et al. 2001). A square-shaped frame is generally used and can easily be made from PVC pipe or other readily-available materials. The data collected within each quadrat and the way the quadrats are arranged on the site depend on the goals of the project and available resources.

The first task is to determine the number of quadrats to sample, and the second is to determine how, and where, to locate them within the site. If data have been collected previously with a ¼ m^2 size quadrat, then the standard deviation of the measure of interest (such as species richness) can be used to calculate the appropriate sample size (see Elzinga et al. for formulas). If such pilot data do not exist, which will often be the case, then data from similar sites may be used to estimate sample size.

Often, researchers will simply use a "rule of thumb" that recommends 20-100 quadrats per area of interest[1], where the number of quadrats increases with the size and heterogeneity of the area. How much to increase the number often is based on a subjective sense of whether the number

[1] Throughout this document "area of interest" or simply "area" will be used to refer to the sample universe, or the reasonably homogeneous area about which generalizations will be made based on the sample data. Sometimes this will be an entire site, but more often it will be a sub-habitat within the site. For example, a site may contain a remnant prairie and a degraded former hayfield, each of which would be considered its own "area of interest" for sampling purposes, because data from one of these areas would not be representative of the natural community within the other area.

and placement of quadrats generally captures the variation known to exist at the site. If these subjective methods are based on many years of experience monitoring similar sites, *and* if they can be used without biasing the data toward particular species or other variables, then they can be used with reasonable confidence. However, the best way to ensure that sample size is adequate is to use the calculations referenced above, using data from similar sites to calculate the needed standard deviation.

Placing these 20-100 quadrats at random throughout the area allows good dispersion throughout the area but is usually prohibitive from a logistical standpoint due to the time required to walk to each individual quadrat. The recommended method is instead to locate the quadrats along a straight line, called a transect. One need only locate the beginning of the transect and determine its orientation and then place the quadrats at regular or random intervals along it.

The number of transects, and consequently the number of quadrats per transect, is determined by balancing the need for greater dispersion throughout the area with the need for efficiency. A rather arbitrary but perfectly defensible standard of 10 quadrats per transect is generally used.

It is important to have at least three independent sample units within the area of interest, due to statistical considerations. Many researchers consider each quadrat to be an independent sample unit, in which case only three quadrats would be necessary in order to have the ability to calculate variances and thus conduct statistical analysis. Of course, three quadrats is not sufficient to capture an area's variation, but from a purely statistical point of view three is the bare minimum. Many other researchers do not consider each quadrat to be independent and instead consider the transect to be the unit of measurement, with the quadrats within each transect averaged to provide the species number (or other measure) for that transect. In this case, three transects is the minimum number required to conduct statistical analysis. The decision on independence is a subjective one, so the number of transects is up to the researcher. The safe route is to include at least three transects so that the data may be analyzed either by transect or by quadrat, depending on the point of view of the reviewer. If only 20 quadrats are to be sampled, then three transects of seven quadrats each could be used.

After determining the number of transects and their length (or number of quadrats), the next step is to determine their locations. Both random and systematic methods provide an unbiased means of transect location, and a combination of the two is recommended here with the use of a grid method. It should be noted, however, that at times the grid method can be impractical because, for example, a big pond cuts right through the middle of the area, or the area isn't as homogeneous as expected and the grid-placed transects end up missing a key part of the site. Below the description of the grid method are some considerations for ensuring an unbiased placement of transects and quadrats when the grid method is not ideal.

For the grid method, first, determine the number of transects, their length (100-200 meters is recommended), and their orientation. If the site is long and narrow there may be no choice but to orient the transects, say, east-west. If a 100-meter transect will fit in any direction, then flip a coin to determine N-S or E-W. If there are ecological gradients you want to capture within a single transect, then it is fine to orient the transect to align with that gradient, but the final placement of the transect must be done randomly or systematically, not placed within a particular spot of interest.

Now that we have, say, three 100-meter transects oriented E-W, we determine the N-S distance within the area and divide this into fourths (if there were five transects, we would divide it into sixths). Let's say one-fourth of the N-S distance is 60 meters. Now choose a random number between 1 and 60, and this determines the N-S placement of the first transect. The other transects get placed at 60-meter intervals north of this first transect.

Now look at the E-W distance of the area and subtract the 100-meter length of the transect from this number. If the site is 400-meters wide, then our value is 300. Choose a random number between 1 and 300, and this determines the E-W starting point for the transects. All transects can begin the same distance from the western edge, or this randomization can be done anew for each transect.

Since few sites are exact rectangles, there will undoubtedly be necessary adjustments to this basic method. If, for example, the southern half of the site is more narrow than the northern half, then the E-W number (300 in our example) will be different for each transect. Parallel transects are not necessary but will generally be easier to locate in the field, with less need to re-do their placement due to intersecting lines. The length of the transect can be shortened to accommodate small areas or lengthened to increase efficiency within larger areas, again, so long as this is done in an unbiased manner.

As mentioned above, there may be reasons that a grid method is impractical, such as site heterogeneity. For a heterogeneous site, it is critical to break the site up into sub-areas, so that the sampling within each sub-area provides a representative sample of this area. Taken together, all of the sample sets for all of the sub-areas will provide an accurate representation of the entire site. Within each sub-area, one should use a random or systematic method for placing transects. If there is only room for a single transect within a sub-area, then a good rule of thumb is to center the transect as much as possible within the area. If there is room for two or three transects, then placing them at regular intervals will help get the best dispersion (this is essentially the point of the grid method). If there is one specific spot that the researchers feel best represents the area, then the researchers should ask themselves why they think this is the case. In truth, if there is only one spot that "feels" right, then probably this area does *not*, in fact, represent the surrounding area, but is instead an anomalous area that should be considered separately.

If transect placement is difficult to do without bias, then a good adjustment would be to place quadrats at random distances to the right and left of the transect line, to ensure that the final collection of data is unbiased. Even if transect placement is unbiased, using a random rather than regular (i.e., every ten meters) method to place quadrats along the transect is fine, if this method is logistically easier for the monitors. The only drawback to randomly placing quadrats is that dispersion along the transect will be lower, so some quadrats may be clustered together while others are sparsely separated. This is not a problem statistically, so long as the method is truly random.

Many alterations in the basic grid method are acceptable, but the only non-negotiable rule is that transects (or quadrats) be located according to a method that is not biased with regard to the variables being measured within the quadrats. It is important to check one's method against this standard, and to have it reviewed by a colleague for bias as well.

A final design consideration is the choice of permanent transects that will be re-visited with each subsequent visit versus re-randomized transects that will be located anew with each visit. Both methods are statistically and ecologically valid, and each has its own set of pros and cons. Permanent transects will show less variability among visits than will re-randomized transects, and thus the power to detect changes will be greater and the number of transects can be smaller. However, permanent transects require the monitors to spend time precisely re-locating the transect each visit. In addition, if the location of a permanent transect is known to land managers, consultants, or stewards, it is possible that these practitioners might begin treating the transect area with more care than the other areas, either deliberately or not, thus decreasing the extent to which the transect area represents the entire area of interest. Re-randomizing transects each visit requires less time in the field per transect and does not introduce the possibility of future bias, but the data will show more variation from year to year, and thus sample size will likely need to be higher than with permanent transects (which may offset the time saved from not re-locating a permanent transect). The choice of permanent versus re-randomized transects is up to the researchers and project managers, depending on which of these issues is most compelling to the team.

Field Protocol

Once the transects have been located on paper or screen, conduct the field protocol as follows. If the site is large, try to locate the transects in the field prior to the date of monitoring, as locating the transects may take considerable time. For permanent transects, mark the start of the transect with flags or flagging, as well as a more permanent marker such as a metal stake pounded low into the ground. If there are obvious landmarks that will assist in finding the transect location in future years (for example, seven meters due east of the edge of a wetland), note these with as much detail as possible.

If you will be re-sampling the same quadrat locations in future years, then using a meter tape in the field will help ensure you get close to the same spots. Locate the transect starting point and walk in the designated compass direction, dragging the meter tape along while another person holds it at the starting point. Once 100 meters is reached, lie the meter tape down, leaving it stretched across the 100-m distance, and walk back to the start. On the way out, be sure to keep the tape to your right and walk along its left, and walk on this same side upon your return, so that you aren't trampling the areas you will be sampling.

Walk to the 10-meter mark along the left side of the tape, and place the lower left corner of the quadrat frame just to the right of (tangent to) the 10-meter mark. The placement of the frame relative to the tape is arbitrary but must be decided beforehand and consistent throughout.

Using a meter tape can be time-consuming, especially for long transects, and if re-locating the quadrats is not important, then paces can be used to determine the 10-meter intervals (be sure to determine your paces beforehand, using a meter tape, to determine how many of your steps over rough ground equal 10 meters). An objective rule must be used to make the final quadrat placement, as it is otherwise just too tempting to place the quadrat right on top of your favorite species. The rule could be, for example, placing the corner of the quadrat at the end of your right big toe.

Record the name of every species within the quadrat and estimate its percent cover within the frame. Include any plant that is within the frame, even if its roots lie outside the frame (but only estimate coverage within the frame itself). Plants may overlap, so the total coverage often will be greater than 100%. If there is little bare ground and this is not expected to change over time, then it is not necessary to record percent bare ground. (This item is more important in woodlands, where degradation often results in significant bare ground.)

A standard piece of 8.5 x 11" paper covers 24% of a ¼-m^2 quadrat, and a 3 x 5" index card (roughly the size of a woman's hand) covers 4%. It is recommended that more than one person estimate coverage for the first several quadrats, so that a consensus can be reached and estimates roughly calibrated.

After the first quadrat is complete, place the second quadrat frame at the 20-meter mark, and repeat the sampling protocol. Continue until all 10-20 quadrats for that transect are complete, and then move on to the next transect.

For time-intensive, quantitative monitoring, it is usually desirable to confine the monitoring to one visit per season, rather than attempting to capture both spring and summer flora in two separate visits. For prairies, the best time to sample is in late summer or early fall, when all species have reached their full size and their relative abundances are stable. The number of spring ephemerals in prairies is small, so most species will be identifiable in late summer, though a few will certainly be missed. Most sedges will have dropped their seeds by this time, so identification of *Carex* species may be difficult. If identifying *Carex* to species is important to the project, monitors may visit the transects in June and July, walking the transect without a quadrat frame and taking an inventory of all *Carex* species and noting relative abundances, vegetative identifying features, and other information that will help the late summer monitors identify *Carex* species.

How often to repeat the sampling depends on the rate of change expected and the project goals. If the goal is, say, to track the reduction in tall goldenrod or another species of concern over a five year period of targeted eradication, then annual sampling is appropriate. If, instead, the goal is to track changes in floristic quality overall, then a 2-5 year rotation is more appropriate. Look at the monitoring goals and the restoration goals – what questions are being answered with monitoring, and what changes are we hoping to see with the restoration? – and use other studies or prior restoration projects to determine the rate of change in this variable that can reasonably be expected. Use this information to guide the frequency of sampling.

E/T Species

If endangered and threatened species are of special interest, the quantitative monitoring protocol should be supplemented with a protocol designed specifically for rare species, as they will likely be missed by randomly- or systematically-placed transects. An initial site inventory is a good way to detect the presence of E/T species. If quantitative monitoring of their populations is a project goal, the Plants of Concern protocol provides a regionally standardized method that has been used in the Chicago Wilderness region since 2001. Appendix A describes the protocol in detail, and more information can be found at www.plantsofconcern.org.

Personnel:
At least one team member must be able to accurately identify all of the species encountered. Realistically, even the best experts are stumped occasionally, and in most cases identifying 90% of the species is likely good enough to accurately assess the quality of the site or the extent of threats to site health. If it is very important to the project goals that, say, a particular rare sub-species is detected if present, then you will need to ensure that the project botanist is highly qualified in rare prairie plant identification. If, instead, you want an accurate measure of the Floristic Quality Assessment Index (FQI), then missing one rare plant that only occurs in one quadrat will hardly register, and you can rely on botanists who are skilled in most prairie plants but may miss a few odd ones here and there. Whether the botanist is a staff member or volunteer is irrelevant as far as data quality is concerned. (It may be quite relevant for reasons of budget, community engagement, or other reasons.) All that matters is the person's skill at plant identification and ability to handle the physical demands of intensive sampling.

Having more than one skilled botanist means that teams can cover several quadrats simultaneously, which is highly recommended for large sites. In addition to skilled botanists, teams should include one data recorder per botanist. This an excellent role for volunteers who spend a lot of time at the site and wish to learn more species or understand what monitoring is about. They can help with logistics and other important tasks.

All monitors must be trained in the field protocol. However, given that the protocol is fairly simple, this training can often take place the day of monitoring by taking extra time as a group with the first several quadrats.

Materials needed in the field:
Flags or flagging for marking transects
100-m measuring tape
1/4-m^2 quadrat frame, made of PVC pipe or other sturdy material. The inside edges must measure ½-m per side.
Compass
GPS unit
Paper and pencils
Clipboard or other writing surface

Alternative Project Goals and Monitoring Protocols
In many cases, the goals of the project will not warrant a full-scale monitoring protocol as described above. For example, a small city park that was originally built on landfill and is now being converted to native prairie vegetation for the benefit of wildlife, people, and stormwater control will have different ecological goals than a 600-acre grassland with remnant prairie soils. For the city park, the goal may not be high floristic quality overall, but rather a reasonably diverse, evenly apportioned, native flora, with aggressive invasives under control. Whatever the

goal, the full-scale monitoring protocol can be scaled back to answer only those questions appropriate to the project goals. Often, a scaled-back protocol will require less time and expertise and fewer resources, which is a strong argument for only monitoring those features that are truly relevant to the project goals. The flow chart on page 13 may be helpful in aligning monitoring protocols with project goals.

One of the simplest ways to roughly track site health is with regular inventories of invasive species, often referred to as "weed scouting." Weed scouts may be staff or volunteers, but this role often fits nicely into the volunteer model, because it is an accessible way for a person to begin learning plant identification and get to know the site. When people spend regular time at a site, they become its eyes and ears, its advocates. Engaging neighbors in weed scouting is an excellent way to develop community investment in the project while also gathering important information about the success of the restoration.

Weed scouting is simply an inventory where only a small subset of species are sought and recorded – namely, the invasive species of concern at the site. Monitors visit the site during the several-week window when each species is in flower, walk the entire site, and record the locations of each target species using a GPS unit. If GPS is not feasible and the site is small enough, the monitor can use verbal descriptions of target species location. In either case, the locations of weeds should be marked with flags or flagging, so that the weeds can easily be found for eradication. The monitors should record a rough measure of abundance in each recorded location: Sparse (one or a few plants), Scattered (many plants over a small area), or Dense (heavy infestation within a small area).

Weed scouting is most effective when there is immediate communication between the scout and the management crew, so that crews can visit the site soon after the scouting report to eradicate the weeds. Thus, weed scouting accomplishes immediate adaptive management, while also providing long-term data on invasives abundance.

If additional species or features other than aggressive weeds are also of interest, the weed scout protocol can of course be modified to include them. Simply include these species or features on the scouting list along with the target weeds. For example, if human trampling is a concern, one can record the location and extent of trampling on each visit.

If diversity is another goal of the project, the full-scale monitoring protocol can be adapted by identifying only the single most dominant species -- the one with greatest abundance -- and noting its percent cover. Using these data, one can calculate the Berger-Parker diversity index, which is simply the reciprocal of the species' percent cover (Magurran 2004). This index provides a measure of evenness, or the degree to which the site is dominated by a single species. In a site that is somewhat larger than, say, a city park, but that is being managed as prairie, it will be important to stay on top of woody invasives at a time scale that may be shorter than the monitoring interval. For example, often land managers will cut and herbicide tall woody shrubs but in subsequent years will miss the many resprouts that are hidden by tall prairie grasses. A simple modification of the transect-quadrat protocol method can address this issue by only recording percent cover by woody species. This protocol can be conducted by volunteers or staff who have no botanical identification knowledge and is a very quick method that can easily be repeated on an annual basis.

If a full FQI is desired, then the full protocol can of course be used. On a small site, the number of quadrats will be small, perhaps 20, and thus will represent a manageable amount of work. The work still requires a botanist who can identify all species and a data recorder to assist him/her in the field.

One way to decrease the time investment while also conducting full-scale quantitative monitoring is to increase the time interval between monitoring visits. A 5- to 10-year rotation may be sufficient to capture significant changes without overtaxing personnel and resource availability. Annual weed scouting could supplement this program, to ensure that project managers stay on top of aggressive weeds that could become out of control in the interval between monitoring visits.

Finally, a full site inventory can be conducted on a regular basis, such as annually or biennially, if a full species list is desired and the site is small enough for this to be practical. Simply walk the entire site and record the presence of each species, without noting abundances.

Personnel:
Weed scouting can be done by one or more volunteers or staff who have been trained to identify the invasives of concern. They also must undergo a field training session as well as training in GPS or other means of recording the data. Clear communication between monitors and land managers is essential, so that weeds can be controlled during the optimum time window. Monitoring woody plants requires no botanical expertise and is an excellent opportunity to engage a person who in enthusiastic and reliable but not trained in botany.

If a full-scale monitoring effort is planned, then the same personnel considerations apply as in the previous section. If a scaled-back effort is planned, with only species dominance recorded, then volunteers or staff with little botanical expertise can be easily trained in the method. Familiarity with prairie species is recommended, so that monitors can distinguish one species from another – knowing their species identities is not important, but it is important to be able to tell that quadrat A has, say, 12 different species, and that the dominant species in quadrat B is different from the one in quadrat A.

Materials needed in the field for weed scouting:
Flags or flagging for marking weed patches
GPS unit if using GPS
Paper and pencils
Clipboard or other writing surface

Materials needed in the field for woody plant monitoring:
GPS unit if using GPS
Paper and pencils
Clipboard or other writing surface

Materials needed in the field for transect-quadrat monitoring:
Flags or flagging for marking transects
100-m measuring tape
1/4-m^2 quadrat frame, made of PVC pipe or other sturdy material. The inside edges must measure ½-m per side.
Compass
GPS unit
Paper and pencils
Clipboard or other writing surface

Statistics and Data Analysis

The type of data analysis should stem directly from the project goals. For example, if the goal is to control invasives and the field method is weed scouting, then data analysis would involve mapping the locations of weeds, keeping track of weed abundance (sparse, scattered, or dense), and tracking changes in weed abundance over time.

Where a more complete picture of site health is desired, the use of a diversity index is recommended. Many diversity indices are used to describe the ecological quality, biodiversity, or health of biological communities, and each index tells us something unique about that community. Taken together, these indices provide a rich, complex picture of a community's condition; however, it is usually best to rely on just a few indices that most clearly describe the factors of highest priority to the project.

Two frequently used metrics are species richness (a species count) and evenness, which indicates the degree to which a community is dominated by only one or a few species. The Berger-Parker index describe above is one example of an evenness index. Two more widely used evenness indices are Simpson's Index and the Shannon-Weiner Index (Magurran 2004). However, some studies have found that these metrics alone were inadequate to describe differences in quality among biological communities (Lydy *et al.* 2000; Cao *et al.* 1996). Many other indices have been developed to describe the diversity and integrity of biological communities, with varying degrees of complexity (see Schleuter *et al.* 2010; Hamilton 2005).

Swink and Wilhelm (1994) and Taft *et al.* (1997) introduced the Coefficient of Conservatism and its related Floristic Quality Assessment (FQA) to provide a means of distinguishing differences among vegetation communities, based on the degree to which the component species are typically associated with high quality plant communities. Each species has been assigned a Coefficient of Conservatism, or C-value, where a value of 10 indicates fidelity to undisturbed or remnant natural areas and a value of 0 indicates a weedy species. Taft *et al.* (2006) found that FQA explained a greater degree of variance among plant communities than did species richness or evenness. The FQA analysis method has been widely adopted within the Chicago Wilderness conservation- and research community and provides a reliable means of describing the quality of vegetation communities.

Local studies have shown that the mean cover-weighted Floristic Quality Index (FQI) per quadrat is very sensitive to changes over time (Packard and Glennemeier, unpublished manuscript). Specifically, FQI = (Mean C) x √N, where C is the Coefficient of Conservatism and N is the number of species (typically native species only).

For the mean cover-weighted FQI per plot, weighted mean C is calculated as follows: $\frac{\sum_{i=1}^{S} c_i p_i}{\sum_{i=1}^{S} p_i}$, where *c* is the C-value of species *i*, and *p* is the percent cover of species *i* within the plot, for all *S* species within the plot. This weighted mean C is then used in the calculation of FQI, as above.

An additional metric that adds information not explicitly provided with the cover-weighted FQI is the prevalence of invasive species, expressed either as frequency (the percent of quadrats that contained at least one invasive species) or as mean abundance per quadrat. If the project goals include reduction in a specific invasive species, then of course the analysis should include the frequency and/or mean abundance of that species.

It also can be helpful to report the number of native species. While species number is incorporated into FQI, pulling it out provides a number that practitioners as well as the public can visualize and easily understand. It can sometimes also be useful to report native Mean C, the other component of FQI, because native Mean C can be viewed as a measure of an area's potential -- even having a tiny sprig of a single conservative plant in the quadrat can boost the quadrat's Mean C considerably, and these little sprigs could spread if given the chance.

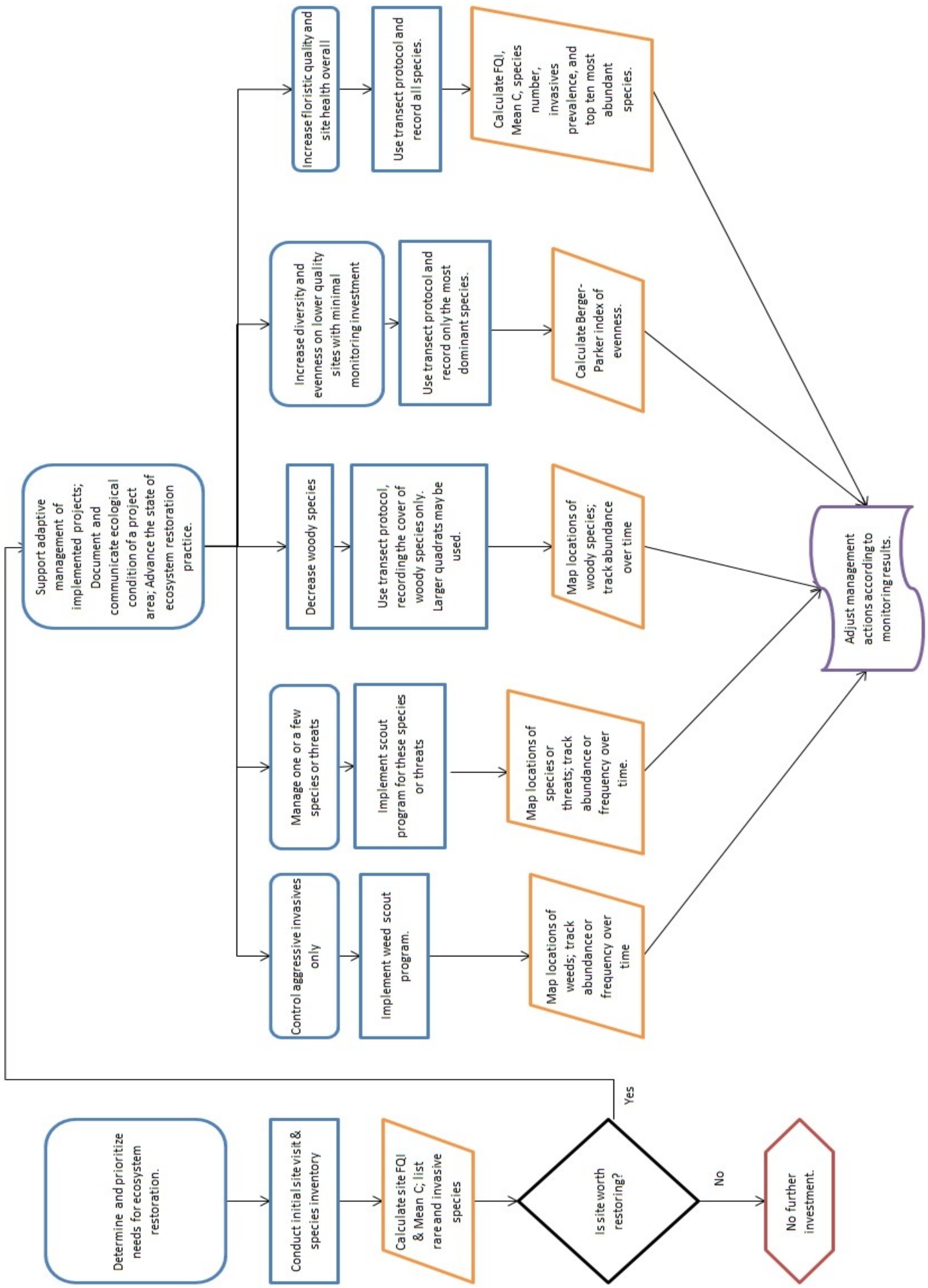
Finally, it is very illustrative to list the top ten most abundant species, in descending order of abundance, expressed as the sum of cover values for all quadrats in the study for each species. This clearly distinguishes areas that are dominated by invasives or weedy species from those that have a more even representation of conservative species. Full species lists are also useful, especially when looking for establishment of species that have been spread by seed.

Adaptive Management

The main purpose for all of the work described herein is to conduct adaptive management; that is, to learn from the data and adjust future management actions accordingly. The project goals have driven the design of the monitoring protocol and the data analysis, and in this final step they drive adaptive management as well. For example, if tall goldenrod control is a project goal, and the data show that tall goldenrod has increased, then a different management strategy needs to be implemented. If an increase in overall floristic quality is the goal, and FQI is stagnant, then perhaps more or better seed needs to be brought in, or invasives more aggressively controlled, or soil type re-examined.

The basic principle of adaptive management is simple -- to follow through with common sense, science-based adjustments to management after learning from the data how prior management has affected project goals. And yet, in spite of this simplicity, adaptive management is very often neglected, which makes monitoring itself a bit of an exercise in futility. The main reason it is neglected is likely time and resources, and a resistance to changing course on a ship that is already in motion. Making a commitment to adaptive management as part of the project's explicit goals is an important step toward ensuring a flexible, successful restoration project.

Monitoring Protocol Flow Chart



Bird Community

See Appendix B for Standard Bird Monitoring Protocols for Grasslands and Prairie

Component 2 – Structural Sustainability

Stream Hydraulics & Habitat

Hydraulic parameters will be monitored at each woody debris jam complex. In order for woody debris jams to provide conditions for lotic macroinvertebrates and fishes, critical flow must be induced over the woody debris. Critical flow will be monitored through observation and calculation. Helical flow is also important as water flows over the woody debris jams and into the pool at meander bends. Helical flow is a cork-screw effect water under goes as changes course in a meander bend. This effect can be observed through placing semi-buoyant material in the water which becomes entrained in the flow pattern. The phenomenon is important to stream fishes that depend on flowing water to bring food to them. Other data would be taken at certain cross-sections as well to record how the channel is developing, which includes velocity, stream morphology, and substrate counts.

Component 3 – Planning Goal & Objectives

The principal goal of a resulting project is to restore stream, riparian, wetland and buffering plant communities to provide habitat for migratory birds and local fish and wildlife. Planning objectives for this study are as follows:

- Objective 1 – Reestablish Hydrology to Support Natural Communities

Currently, Spring Creek Forest Preserve is recovering from decades of intensive agriculture. This included altering the site's hydrology via installing vast drain tile networks, excavating ditches, channelizing streams, and grading-out micro-topography. Thusly, changes to the current hydrologic regime desired are those that will reestablish hydroperiods and rehydrate former hydric soil units. These affects would be sustained over the life of the project and optimistically in perpetuity. This objective seeks to reestablish natural hydrologic and hydraulic parameters to support critical wetland and riparian habitats within the Spring Creek natural area. Improvement is predicted via the increase in quantity (acres) and increase in quality (FQI Value of the FQA) of native plant communities.

- Objective 2 – Reestablish Wetland, Riparian & Buffering Native Plant Communities

Currently, Spring Creek wetland, riparian and important buffering habitats are dominated by non-native and invasive plant species. This condition resulted from alteration to the natural hydrologic regime, disturbance to native soils, prevention of natural processes, and the sowing of non-native and native weedy (ruderal) plants. The domination of riparian plant communities by certain species such as buckthorn, honeysuckle and multiflora rose have also caused stream hydraulics and geomorphology to unravel, further exacerbating floodplain hydrologic issues. Thusly, the changes to the native plant community desired are those that will reestablish a base native plant community that will diversify overtime. These affects would be sustained and increased over the life of the project and optimistically in perpetuity. This objective seeks to reestablish native plant community richness and structure to support critical wetland and riparian habitats within the Spring Creek natural area. Improvement is predicted via the increase in quantity (acres) and increase in quality (FQI Value of the FQA) of native plant communities.

These objectives would be assessed the same way as the FWOP and FWP project benefits were modeled as described in the Main Report, Section 2.2 – Habitat Quality Forecasting.

Monitoring Responsibilities

The USACE, Chicago District will be responsible for monitoring stream hydraulics, fish and vegetation for this project. Due to its status as an Important Bird Area, there is already a strong bird monitoring effort in place at Spring Creek Valley made up of several non-profit organizations. Results from these bird monitoring efforts will be incorporated into the yearly reports.

Monitoring Costs & Funding Schedule

Tasks	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Component 1	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 50,000
Component 2	$-	$ 1,000	$	$ 1,000	$ -	$ 1,000	$	$ 1,000	$ _	$ 1,000	$ 5,000
Component 3			$1,000	$ -	$ -	$ -	$1,000	$ -	$ -	$ 1,000	$ 3,000
Final Report	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$10,000	$ 10,000
Total	$5,000	$ 6,000	$6,000	$ 6,000	$5,000	$ 6,000	$6,000	$ 6,000	$5,000	$17,000	$ 68,000

Reporting Results

A yearly monitoring summary report would be drafted by the USACE, Chicago District that briefly summarizes the data collected and determines if adaptive management is needed. A final monitoring report would be drafted that details the outcomes of the restoration project.

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Appendix A. Plants of Concern Rare Plant Monitoring Protocol Excerpted with permission from the 2014 Plants of Concern Volunteer Training Manual. More information and a complete protocol can be found at www.plantsofconcern.org.

SUBPOPULATION SIZE ESTIMATION AND PERCENT REPRODUCTIVE PROTOCOL

For subpopulations greater than 250 (optional protocol, but encouraged – the size classes on the monitoring form for plant numbers > 100 are acceptable)

For POC, this is a different methodology than presented in the 2007 Manual for estimating plant numbers, which we think is more accurate than the former method of counting plants in quadrats. You will need a calculator. (Refer to Figures 1 and 2). If plants in the subpopulation are in separate sections surrounded by a large gap, you may repeat this protocol in each section to arrive at two or more estimates that can be added for the total.

1. Flag the perimeter or outside edge of the population, placing flags about 2 m apart.

2. Measure the N-S extent of the population at its widest: ________________ meters (m)

3. Measure the E-W extent of the population at its widest: ________________ meters (m)

4. Estimate the subpopulation area by multiplying N-S & E-W extents: ______________meters squared (m^2)

For very large populations, it is possible to determine these measurements from GPS readings or aerial photography. Please contact the POC Research Assistant for assistance with this.

5. Mentally put a box around the population, from the N-S and E-W extents used above. Use this whole imaginary box when setting up your transects (Figure 2).

6. Set a baseline along the short edge of the population, then run 3 parallel transect lines of 30-50 meters each (**record these lengths**) at right angles (perpendicular) to the baseline through the long orientation of the population starting at **3 random points** (you may choose a random starting point and then set the lines at equal intervals.)

Transect 1 Length __________m
Transect 2 Length __________m
Transect 3 Length __________m

7. Count all the plants within a meter (or two meters)* to the left (or right) of the tape; pick one and be consistent. Tally **flowering/fruiting (Fl/Fr** plants**)** and vegetative plants (**Non-Fl/Fr** plants) **separately**.

** If plants are large, count all plants within two meters of the tape; examples of these large plants are Carex bromoides, Comptonia peregrina, Rubus odoratus, Valeriana edulis var. ciliata, or Cypripedium candidum. If plants are smaller, count all within one meter.*

8. Add all the tallied plants from all the transects:

__________**Fl/Fr** plants + __________ **Non-Fl/Fr** plants = __________number of plants in transects

9. __________**% Reproductive** = the number of Fl/Fr plants divided by the total number of plants in transect. Enter on monitoring form.

10. ____________Area of the transects (m^2) =add all the transect lengths (m) and multiply by the distance (m) from transects that the plants were counted within (one or two meters.)

11. __________Number of plants per m^2= number of plants in transect divided by the area of the transects.

12. __________Estimate of the total number of plants in the subpopulation = number of plants per m^2 multiplied by the subpopulation area (# 4 above). Enter on monitoring form.

Appendix A (continued).
POPULATION SIZE ESTIMATION EXERCISE DIAGRAMS
Excerpted with permission from the 2014 Plants of Concern Volunteer Training Manual

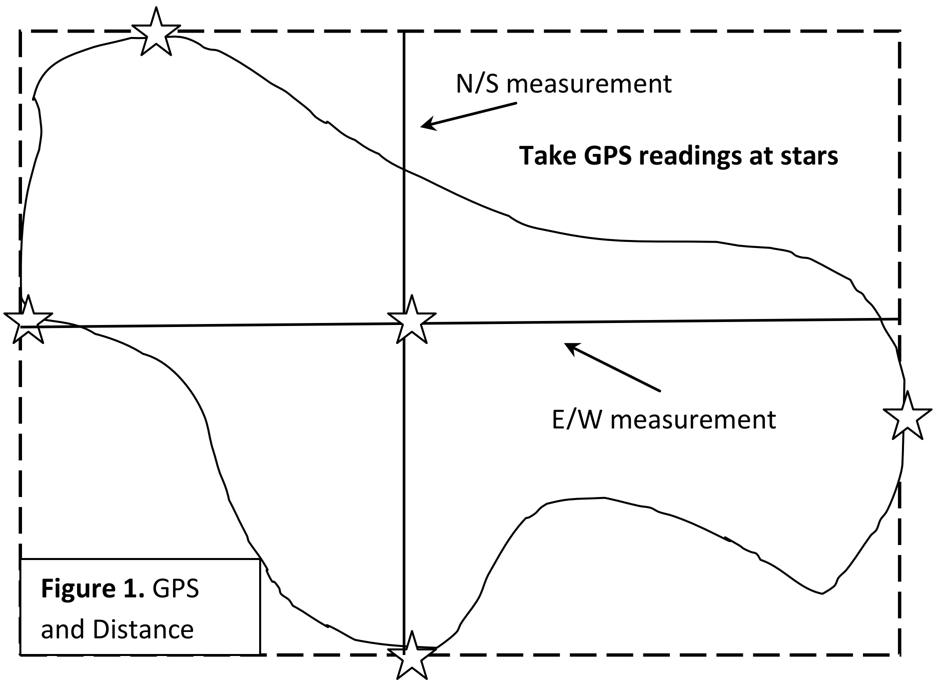


Figure 1. GPS and Distance

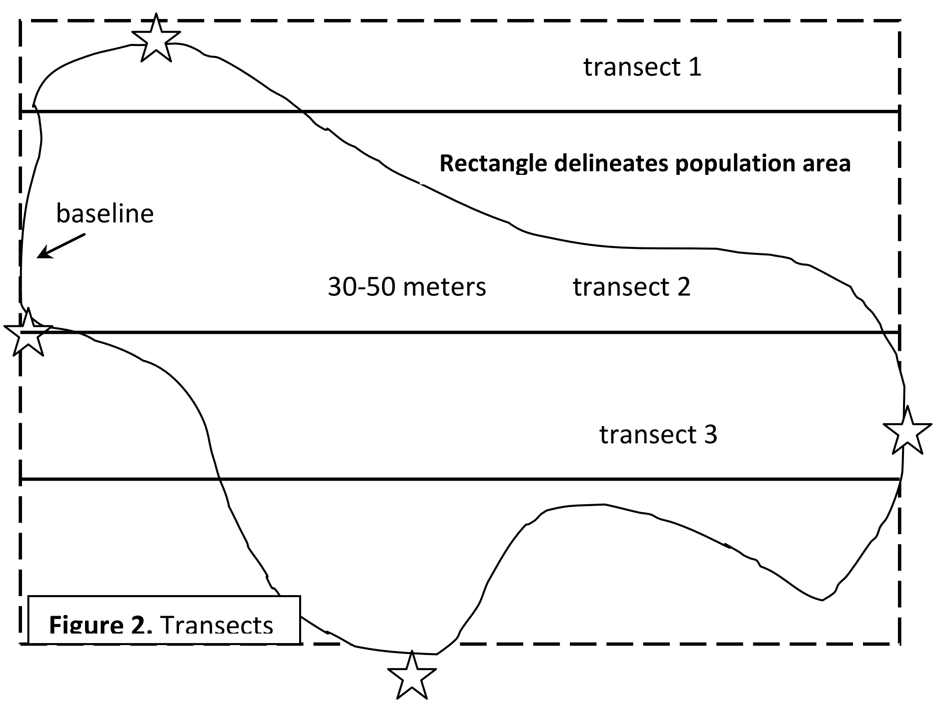


Figure 2. Transects

Appendix B. Standard Bird Monitoring Protocols for Grasslands and Prairie

Prepared by Judy Pollock for the U.S. Army Corps of Engineers, Chicago District

Many different protocols exist for monitoring birds within grasslands and prairies. Since each method provides somewhat different information, it is important to settle on a standard protocol that will be used throughout the duration of a project, so that data can be reliably compared over time. Using the same protocol across different projects provides the added ability to compare the effectiveness of restoration across sites in order to generate more robust conclusions to inform restoration plans going forward, as well as supporting regional restoration goals.

The most successful ecosystem restoration projects not only include a well-articulated monitoring and adaptive management plan, but also a plan for engaging partners and collaborators in project design, implementation, monitoring, management, and community engagement. These recommendations are an important component of successful restoration projects within urban areas such as Chicago Wilderness, and include a citizen science protocol – the BCN Survey.

The following monitoring recommendations include a few protocols that can be adapted to a variety of different situations. They draw upon the most current thinking in the rapidly-evolving field of avian statistics and they incorporate resources available to Chicago-area organizations. There are many factors that determine our ability to detect a bird – for example, time of day, the acuteness of the observer's hearing, or how loudly the bird sings. Methods exist which determine the probability that a bird is occupying the site based on analysis of the data that has been collected. These methods, however, require additional time and/or training. Some of our protocols allow for detection probability, for cases where it is deemed valuable to make the extra investment. Some demonstrate how to incorporate data from existing citizen science efforts such as eBird and the BCN Survey in order to reduce the number of visits needed. And some more simple methods are offered for situations where detectability analysis is not chosen, due to time or resource constraints, or the features of a particular site. For this report, we chose two specific sites and one invented site to compare in order to show how to adapt the various protocols to different situations. If the protocols described herein are not adequate for a given situation, guidance can be found in Appendix C and in Knutson 2008 Standard Operation Procedure (SOP) #1: Sampling Designs; Section 3: Objectives

Finally, while this document addresses only bird monitoring, it is important to consider any additional taxa that will be monitored, so that efforts can be coordinated. Placing bird point count circles along vegetation transects, for example, can allow conclusions to be drawn about the impact of vegetation changes on bird communities, as well as providing important data about flora.

Overview

This document contains three different scenarios which use a number of bird monitoring protocols. Each scenario follows the process laid out in the Northeast Coordinated Bird Monitoring Partnership's 2007 guide, A Framework for Coordinated Bird Monitoring in the Northeast. Included text from that manual appears in the orange boxes. The first two scenarios are actual sites and the third is a hypothetical site. These were chosen to allow for a range of protocols to be presented. Other protocols are suggested in Appendix C.

Example 1: Eugene Field Park. A small urban park with incomplete bird data, no known nesting birds of concern and a few known migrant birds of concern. The park contains a small prairie with ephemeral wetlands, a shoreline that was cleared of woody vegetation, shrubby areas and a small savanna. Protocols described for this site include **inventory, paired point study and area survey**. Inventory protocol provides status assessment and is a first step in situations where little is known about the bird life. Paired point studies provide effectiveness monitoring and are useful for answering questions about the impacts of management changes on migratory or breeding bird habitat. An area survey may be appropriate in certain situations where point counts are not feasible or desired.

Example 2: Orland Grassland. A large prairie and wetland restoration with different partners using varied restoration methods. Eleven years of citizen science bird monitoring data from the BCN Survey as well as plant data from the Orland Grassland Volunteers are available. Breeding grassland birds are common. Protocol described is the **BCN Survey breeding season point count augmented with repeated point count surveys**. This protocol provides for trends analysis and effectiveness monitoring and is appropriate for a situation with multiple observers and time for repeat visits.

Example 3: Hypothetical large grassland without existing bird data. This describes a protocol that incorporates current thinking about detection probability. It would be appropriate in sites where a trained biologist or monitor is available and which has no history of existing monitoring. Protocol described is **point counts with distance sampling and time removal**. This protocol provides for trends analysis and effectiveness monitoring and is appropriate for one observer who is expert at recognizing birds by ear and estimating distances to bird songs and calls, although it is helpful to have an assistant. Some meaningful results can be obtained in one visit although multiple visits deliver more refined results.

Contents

Example 1: Eugene Field Park

A small urban park with incomplete bird data, no known nesting birds of concern and a few known migrant birds of concern. Protocols described include inventory, paired point study and area survey.

Step 1: Establish a clear purpose

> *Problem statements identify the populations of concern within clear boundaries of space and time, as well as the management issues or threats that are believed to limit them. A problem statement also might describe policy, regulatory, or management decisions that could benefit the target species. Include lists of local species of concern status of different local species assemblages, and sources of background information about bird populations at local sites.*

Define the problem

Eugene Field Park is a small 8.5-acre park along the Chicago River, owned by the Chicago Park District. The park contains a small prairie with ephemeral wetlands, a bank that was cleared of woody vegetation, shrubby areas and a small savanna. There are five distinct features created by the restoration that would be used by different suites of birds (Fig. 1):

- a wet lawn was converted to restored prairie
- within the restored prairie is an emergent wetland
- unassociated woody growth was cleared from the northeast bank of the river and herbaceous plantings were installed
- a portion of the herbaceous bank has shrub cover
- a small restored savanna exists under a few oaks on the north edge of the prairie.

Our charge is to develop protocols for grasslands. In developing our monitoring plan we will take a broad view of grassland habitats. Sedge meadows, prairie, shrub prairie and savanna are all grassland systems and will be included in this monitoring plan.

Figure 1. Gompers Park habitat areas.

This project addressed two issues: a wet, difficult to maintain lawn area and a riverbank of invasive trees and bare ground that was prone to erosion. In all likelihood the project did not make new habitat for many birds of conservation concern. However, an opportunity exists to quantify the changes in bird populations that result from the conversion of lawn to a small prairie and also from the conversion of wooded bank to herbaceous bank. The results would inform future Corps projects as well as suggest management improvements on this project. In addition, through its goal of restoring habitat, the project addressed the problem of a lack of habitat for migratory birds, including birds of conservation concern, in urban areas. urban areas.

Monitoring programs typically aim to assess the population status of one or more species, quantify population trends, identify the effects of environmental changes on populations, or determine the effectiveness of efforts to stabilize or increase populations. It is sometimes possible to achieve all four types of objectives simultaneously.

Status assessment involves measuring the current condition of populations to inform a pressing management or conservation decision and/or establish a baseline for quantifying future change. Related objectives may be to inventory species, describe species-habitat relationships, identify critical habitat, or compare present population size to a desired level.

Trend monitoring calls for surveys to be repeated at the same locations in order to estimate rates of change in status measures (e.g., occurrence, distribution, abundance, vital rates, and/or health).

Effects monitoring uses covariates to link changes in bird populations to changes in the environment. This approach can help explain why populations rise or fall. Monitoring effects also can aid in projecting impacts of development, climate change, and other threats.

Effectiveness monitoring, also known as evaluation, consists of monitoring populations before and after conservation decisions are implemented. This is a critical component of adaptive management, an iterative process that relies on monitoring results to formulate and refine conservation decisions (Walters and Holling 1990).

It is important to make monitoring objectives specific and quantifiable. They may start out broad, but should be sharpened after a partnership is formalized and pilot data are available.

Identify and consult stakeholders

Stakeholders at this site include the landowner (the Chicago Park District), the Army Corps of Engineers, the Eugene Field Park Advisory Council, the Alderman, neighbors and park users, the CPD volunteer stewardship group including the steward, local birders including the Chicago Audubon Society, and the Bird Conservation Network which aggregates local bird data.

Set a conservation goal

give examples, small medium and large

The ecosystem restoration goals described in the feasibility study are:
1) Restore habitat to the Chicago River North Branch
2) Restore a riparian corridor
3) Restore diverse prairie, oak savanna and wetland swale communities.

Of these, migratory landbirds and perhaps a few nesting birds would benefit from goals 2 and 3. Wading birds would benefit from goal 1. Because this monitoring plan focuses on grasslands, we will not consider wading birds and waterfowl using the river. We will, however, consider the all migratory landbirds that use the site before and after the restoration, including woodland species, since the conversion to grassland will impact them. Because this site is too small to attract nesting grassland birds, this example will consider other bird conservation values of small prairies.

Appropriate bird conservation goals are:
Large: to attract appropriate nesting landbirds of concern to the site (shrubland and savanna birds)
Medium: to increase abundance and diversity of migratory landbirds using the riparian corridor
Small: to maintain pre-treatment population levels of migratory and nesting birds of conservation concern

Develop monitoring objectives that are linked to the conservation goal

Site-specific conservation objectives of this planning and design analysis for aquatic ecosystem restoration at Eugene Field from the feasibility study are:

1. Establish instream channel complexity
2. Establish flow velocity diversity
3. Improve site specific water quality
4. Increase species richness of native plant communities
5. **Increase species richness of aquatic communities**
6. **Increase species richness of riparian communities**

Objectives 5 and 6 are the objectives which apply to bird communities; we will consider only Objective 6, which applies to the new grassland riparian strip.

Because there is incomplete bird data at the site, an inventory is needed to determine which birds of concern are using the site. This inventory should cover the breeding and migratory seasons.

To have a complete inventory during the migratory season (when the species composition can change several times a day) many visits are needed. If additional resources are available, a winter inventory would also be useful.

The three broad monitoring objectives below will be made specific and quantifiable after pilot data collected during the inventory stage are available to help establish reasonable standards. It is not expected that grassland birds of concern will nest in such a small prairie. The prairie, wetland and shrubby area can be surveyed during nesting season to determine the breeding bird species composition. It is more likely that birds of concern will use the site during migration season.

Banks stabilization projects like this one occur with some frequency. Changing a walled, unnatural bank to a natural, sloping, vegetated bank adds natural erosion control and bank stabilization. An opportunity exits to evaluate the goal of increasing species richness of riparian communities. The impacts of this particular form of bank stabilization by clearing woody invasives and replacing them with an herbaceous bank and a shrubby bank can be assessed. Comparisons can be made between the herbaceous bank, the shrubby bank, and the river just downstream which has two wooded banks. Similarly, a comparison can be made between the restored prairie and a nearby wet lawn, if the benefits of this action to wildlife need to be proven. These studies would suggest management adaptations as well as allow for a more rigorous quantification of the impacts of this type of grassland bank restoration on bird populations.

Monitoring Objective 1. Assess the population status of species of concern: inventory all species using the prairie, oak savanna, wetland swale and herbaceous/shrubby bank areas in spring, summer and fall.

Monitoring Objective 2. Monitor effects of conservation decisions on populations of migratory birds which use the riparian area, prairie and wetland as a refuge, and on breeding birds of concern that use small prairies and wet meadows, if they are present. Make comparisons to local reference areas to gauge impacts of conversion to prairie and wetland and removal of riparian woody vegetation.

Monitoring Objective 3. Monitor trends of species of concern, if warranted. This would be warranted if species of concern are found in the breeding season and are deemed to be appropriate conservation targets for the project, and if the numbers or species composition of migrants are distinctive in comparison to surrounding habitat. This objective is not addressed in the protocols below. If warranted, either of the point count methods found in scenarios 2 and 3 can be used.

Step 2: Determine whether an existing program or protocol meets your needs.

Cornell Lab of Ornithology's online bird checklist program, eBird, contains inventory data for

Include description of existing programs and protocols
Build on monitoring assets that are fundamentally sound – to assess the suitability of a monitoring program, you can use the online monitoring evaluation tool developed by Southeast Partners in Flight (http://evaluation.sepif.org/index.html).
Form or join a monitoring partnership
Include people with quantitative skills
Define roles of partners

Bird Monitoring programs in the Chicago Wilderness area:
BCN Survey: site-based feedback for land managers; point counts and transects
Northeast Illinois Wetland Study: monitoring wetland bird populations across NE Illinois; uses national protocol
HMANA Hawk Counts: Illinois Beach State Park, Greene Valley Forest Preserve, Fort Sheridan
Critical Trends Assessment Program: statewide biodiversity trends monitoring
MOON Monitoring of Owls and Nightjars in Illinois
Monitoring partnership: Midwest Coordinated Bird Monitoring Partnership
Potential Quantitative Analysis Partners: Midwest Avian Data Center (Point Blue Conservation Science), Field Museum, Prairie Research Institute, Lincoln Park Zoo Urban Wildlife Institute, USGS Lake Michigan Ecological Research Station, land management agencies, biological contractors, UM/GL Joint Venture, LCCs
Banding Studies: inquire of an officer at http://www.ibbainfo.org/home.html, or on the banders' listserv http://www.lsoft.com/scripts/wl.exe?SL1=BIRDBAND&H=LISTSERV.KSU.EDU
Demographic Studies (nest searches): area academic institutions. These are often done by grad students and/or professors, and are linked to a research question of academic interest.

the site entered by birders. One of their protocols, "exhaustive area search" can be useful in compiling an inventory. A limited amount of eBird data exists for the migratory season, indicating that there may not be birds of concern using the site. EBird displays the names of birders who have entered data; these people could be approached to participate in an effort to add inventory data.

The Midwest Avian Data Center (MWADC) has online data storage and analysis for area search censuses, which are time constrained bird censuses, similar to a Christmas Bird Count. Area search censuses differ significantly in that the census areas are defined by habitat rather than by political boundaries. This allows bird relationships to be determined and land management techniques assessed. This method is also ideal for volunteers and observers with limited identification skills. Observers are able to interact, compare notes, and chase down unfamiliar species or sounds. It is ideal for recruiting new observers in that it requires little training and allows skilled observers to train new observers. Non-birders may even participate by serving as recorders or tallying obvious species.

Step 3: Assemble a team of collaborators with complementary interests and skills

affiliation	role	role
Army Corps biologist	ecologist	oversee project, collect data
Bird Conservation Consultant	consultant	develop protocol, recruit volunteers, oversee data collection, collect data
Local bird clubs, individual birders and eBirders	Volunteer birders	collect data
Bird Conservation Consultant, Lincoln Park Zoo Urban Wildlife Institute	consultant	quantitative analysis

Step 4: Summarize the relationship of target populations to other ecosystem elements, processes, and stressors

Summarize life history information for the species or species group of interest

Chicago is located on a major flyway, and an estimated five to seven million migrant birds pass through annually. Over 150 species of landbirds migrate though Chicago during the fall and the spring, including scores of migratory songbird species. Fifty-five landbirds have been identified as birds of conservation concern due to a combination of declining populations and significant threats: 23 that migrate through the region and another 32 that spend the summer here. One permanent resident, the kestrel, is a species of conservation concern. (See Appendix A.) Migratory birds are one of the species guilds of greatest conservation concern using urbanized Chicago landscapes such as this one. They fly at night, making a long journey between their nesting grounds in the north and their wintering grounds in southern states, Mexico, the Caribbean, and Central and South America. They fly over farm fields and expanses of concrete and asphalt to preserves and green spaces. These birds arrive hungry and exhausted. The lakefront concentrates many landbird migrants that fly over the lake and find cover there at daybreak. Ornithologists refer to poor habitat that birds seek out immediately upon landing as "fire escapes" and "quickie marts". During the day, birds often move to the city's rivers, forest preserves and large interior parks ("roadside motels and full service hotels"), especially on days with east winds, which drive birds off the lakefront. These places all provide food and shelter during the most stressful and dangerous time in these birds' lives. Eugene Field Park is such a place.

Many migratory birds travel in mixed-species flocks in search of food and shelter over the course of a day. Different species exploit different niches. For example, among the warblers, there are those that specialize in probing under bark, probing the undersides of leaves, searching aerial leaf litter, or catching flying insects; some preferentially use outer branches, understory, particular heights or certain tree species. Sparrows seek seeds on the ground, and other bird guilds have particular foraging needs. Different plants provide food in different ways: in spring, young tender leaves attract insects which feed insectivores, and flowers feed nectar-drinkers; berries and seeds are important fall food sources, as are insects in the herbaceous layer beneath a savanna canopy; in all seasons leaf litter and bark harbor eggs and larvae. Warblers may be broadly divided into those that use oaks preferentially and those that prefer other trees and shrubs. The phenology of each plant species determines when food is available. This availability needs to coincide with a bird's migratory period. Therefore, structural and species diversity are very important requirements of habitat for migratory birds.

A report describing priority migratory stopover habitat in the Chicago region (Byrne, 2008) assigned the highest ranking to Chicago River sites such as Eugene Field, due to the dense urban development surrounding them and their locations in a wide riparian strip. Emergent insects found on riverbanks are a key resource for migrants.

Threats during the migration period include collisions with windows, towers, vehicles, turbines and other structures, prolonged periods of cold weather which reduce insect availability, predation by cats, and storms which may trap birds over the lake. As blooming periods advance with climate change, there is a mismatch between the availability of food sources and the timing of migration.

Revisit conservation and monitoring objectives

As Eugene Field is dominated by towering cottonwood stumps, evaluating the impact of the raptors that use them on the stopover habitat would be an interesting question that is outside the scope of this current plan.

Build a conceptual model (hypothesis) – A conceptual model is "a hypothesis regarding the expected response of a species or species group to changes in environmental conditions and/or management". This type of model uses written descriptions and/or diagrams to depict cause-and-effect relationships among ecosystem elements, natural processes, and anthropogenic stressors.

The conceptual model at this site is quite simple, due to the small size of the habitat. We predict that removal of riparian woody structure and the addition of a small herbaceous area will have the biggest impact on migratory species richness, and will result in an overall small decline in species richness of migratory birds of conservation concern because more migrant species of concern use woodlands than grasslands, no change in migratory species richness overall, and change in species composition from primarily woodland to a mix of mainly grassland, wetland and savanna birds. We further predict that no birds of conservation concern will nest on site due to its small size and that migratory birds will emerge as the important conservation focus.

Table 1. Hypothesized changes in abundance and species richness

Habitat changes	**Expected response of species groups**	**Net changes to species richness**	**Net change in abundance/richness of species of conservation concern**
Wet lawn converted to small prairie and ephemeral wetlands: increased herbaceous diversity, aquatic and soil invertebrates, and seeds	More species of migrant waterbirds, waterfowl and migrant wetland and grassland landbirds such as swamp and savanna sparrow	gain	Moderate gain in both
Unassociated woody growth replaced by herbaceous plantings on the northeast bank of the river: loss of trees, shrubs, associated invertebrates and cover	Fewer species of migrants of woodlands and forests such as warblers, vireos, and woodpeckers	loss	Large loss in both
Unassociated woody growth replaced by herbaceous bank with some shrub cover: loss of trees, associated invertebrates and cover	Loss of canopy species; reduced numbers of shrub-using species	loss	Moderate loss in both
Small restored savanna under a few oaks: adds herbaceous diversity and insects (food source)	More migrants exploiting herbaceous layer, particularly in late fall	gain	Small gain in both

Identify important response variables and covariates to monitor – Primary response variables will be those parameters of greatest interest based on the conceptual model. They could include variables such as density, seasonal survival, or nest success. To ensure a focused survey design, limit the list of primary response variables, but consider incorporating secondary response variables that can be measured efficiently. This is also a good time to identify covariates known or suspected to affect the target populations. Examples of covariates that may have a direct influence on birds include temperature, precipitation, vegetation structure, food availability, and the abundance of predators. Examples of covariates that may have an indirect influence on birds include elevation, slope, and land use activities that change the context of the sampled locations within the surrounding landscape.

Response variables: presence or absence of bird species, number and species of birds, number and species of birds of conservation concern, habitat used by birds
Habitat Use Covariates: habitat type, date, weather factors (wind direction, movement of front, storms), bird species
Detection Covariates: observer, weather factors (wind direction, storms), time of day

Revisit conservation and monitoring objectives

Same as above.

Step 5: Develop a statistically robust approach to sampling and data analysis

In the most general of terms, adaptive management is a structured, iterative process of decision making where information is collected along the way to better influence future management decisions. When applying this process to the management of wildlife habitat, it is necessary to determine how species within a habitat (or multiple habitats) are influenced by management decisions. To do so, data is often collected from a random subset of locations within an entire habitat to infer properties about the whole population, the basis of statistical inference. When deciding upon a proper protocol to collect and analyze data, it is important to ask a number of questions before going out and collecting data:

1. What is the size of the habitat? Is it feasible to survey the entire area?
2. What types of patterns or processes am I interested in measuring? What type of data would provide the best measurement?
3. If I am trying to determine differences between groups of sites managed in varied ways, how small of a difference am I interested in detecting?
4. What types of birds am I interested in monitoring (e.g. breeding birds, birds during migration, etc.)?

All of these questions will influence study design and statistical analysis. Below, we provide a robust approach for small parks similar to Eugene Field Park, specifically addressing the questions above. This approach can be used to collect the information necessary for an adaptive management decision making process to address monitoring objective 2 and will add to an inventory for objective 1, and can be used to determine trends as described in objective 3 if that is deemed to be worthwhile.

Identify appropriate analytical procedure

While larger plots of land allow for replication in study design (i.e. more locations to conduct independent bird surveys) and therefore more robust analyses, smaller parcels of land can only provide so much information and are often too small to fit the assumptions of most statistical analyses. Regardless, the descriptive information gathered in small parks is useful for management decisions as it can help prioritize projects, identify 'hotspots' of bird diversity, and provide baseline information for an area. For a small site like Eugene Field Park we suggest to first generate a species inventory during the migratory and breeding seasons. Species inventories are simple to conduct in small sites because the surveyor is able to cover the entire area during a few hours. The benefit of species inventories is greatest when little is known about the bird community at a site, and it may potentially locate species of concern.

During the migratory season birds will be arriving at and leaving the park daily, though a number of resident birds may be present for the entire season (e.g. American crows, house sparrows, etc.). As such, conducting a species inventory during the migratory season often requires more counts than during the breeding season because the bird community is dynamic. To collect the most information on the entire migratory community counts should be conducted from mid-March through late May and late August through early November, but if time and budgeting are an issue efforts from late April through mid-May will sample the busiest migration period. Conversely, fewer counts will need to be conducted during the summer season as the birds present are likely those that are breeding. Breeding counts should be conducted twice in June, at least 7 days apart.

Useful descriptive statistics from species inventories

While the initial data that is collected is count data, it can easily be converted to habitat specific species richness, total species richness, or occurrence data that can be plotted and presented in a variety of ways that are useful to land managers. Because we expect specific guilds to respond to habitat change at Eugene Field Park differently we suggest summarizing the count data in multiple ways:

1. Group the actual count data into guilds by habitat type. More explicitly, sum the number of individuals of all species within a guild observed in different habitat types to be used for analysis (e.g. all the grassland birds (see Appendix A) in the prairie portion of Eugene Park). This would be done for each count separately.
2. Guild species richness by habitat type. Count the number of individual species within a guild seen in a particular habitat type (e.g. the number of unique grassland bird species in the prairie portion of Eugene Field Park). This could be a summation over the entire breeding or migratory season or a summation for each count separately.

These numbers can be placed either in a table or plotted out over time (e.g. throughout the migratory season) to get an idea of what species are present over the entire breeding or migratory season or when species richness of particular groups or the entire community is at its highest. (If there are not discrete habitat types at a study site then we suggest making summations over the entire area.)

Summarizing counts in these two ways is useful as it reduces the size and dimensions of a dataset, making the information easier to interpret. In addition, there are other useful descriptive data summaries that can be applied to count data, such as the Shannon-Weiner diversity index or Shannon's diversity index (Nur, 1999) These other descriptive statistics are useful if you are interested in determining if the community is dominated by a small number of highly abundant species or split more evenly. By providing feedback on what species are present, where they are located, and what time of year they are present (i.e. breeding season, migratory season, etc.), land managers can plan management activities at times when they will have the smallest impact on the bird community and possibly use this information to prioritize management efforts.

Effectiveness monitoring for smaller scale management questions

While small sites make most types of statistical analyses difficult, and the dynamic nature of the migratory season adds its own set of challenges, it is possible to conduct repeated-measures paired counts in locations to determine the effect of management actions in specific locations. To illustrate this, we provide an example specifically for Eugene Field Park, but the method is general enough to be converted for use at other sites as well to answer a variety of questions. Portions of the bank of the Chicago River have had the riparian unassociated woody growth removed, and we are specifically interested in how this removal influenced species richness in this area over the migratory season. Because stream banks are relatively linear, we would favor either a line transect or area search, and count all bird species that are present within the boundaries of the managed area. Furthermore, we would also randomly select another portion of the bank far enough away from the managed area (in order to consider the counts independent) and conduct an identical count over the same distance. These counts would be conducted multiple times (i.e. repeated measures).

If we assume independence in counts (because the bird community rapidly changes over the migratory season), fitting a generalized linear model to these data would be the appropriate starting place as count data generally fit a Poisson distribution. However, after assessing model fit, it may be necessary to use a negative binomial or zero-inflated Poisson regression if the data are overdispersed (i.e. there is greater variability in the data than expected based off the model used). After applying the model a one-factor ANOVA can be used to see if there are significant differences in between locations, while the direction and effect size of this relationship can be gathered from the model summary. In this particular case the response variable in this regression would be species richness while the explanatory variable is management type (i.e. with or without woody undergrowth), and there are many free statistical tools that can be used for this type of analysis (e.g. MWADC, TRIM, or program R).

Determine an appropriate method for selecting sample units. Standard approaches include simple or stratified random sampling, systematic sampling, and cluster sampling.
For cause-and-effect monitoring, the sampling design should include replicates of the management action, if possible, and replicates of sites without implementation of management practices (i.e., controls). This replication is necessary to isolate, as much as possible, the management action as the only difference among treatment and control sites.
(Consider desired levels of precision and power to detect change; consider spatial and temporal scope of inference)

Because Eugene Field Park is small in size it is possible to survey the entire area during a count. Therefore, randomized designs are not necessary.

Monitoring Objective 1: Area inventory: entire area can be covered as it is small; no need for sampling. An inventory can take place over the course of one spring and summer, and inventory data can be collected during the course of effectiveness monitoring (Monitoring Objective 2). If no birds of concern are found, there should be no need to repeat the inventory.

Monitoring Objective 2: Effectiveness monitoring: replicates of management action and sites without management action. Paired points should be surveyed at least 6 times within the migratory season (spring and/or fall) for two years.

A study using paired points would yield information about the impacts of this particular form of bank stabilization by clearing woody invasives and replacing them with an herbaceous layer. Points can be established to compare the herbaceous bank, the shrubby bank, the opposite wooded bank, and the river just downstream which has two wooded banks. Similarly, a comparison could be made between the restored prairie and a nearby wet lawn. As the conceptual model for this site focuses on discrete habitat types, and how those habitat types influence breeding and migratory bird populations, it is important that birds are counted within these specific locations. A single species may be observed throughout multiple habitat types within Eugene Field Park, but the numbers of said species should be counted separately within each habitat type in order to make comparisons. Depending on ease of access, particular points within each habitat type may be selected for an observer to count from in order to avoid causing excessive disturbance to migratory and breeding birds. Care should be taken to not double-count individuals.

Delineate the sample frame; stratify for various habitat features. Restrict the stratification of a sample frame to a small number of properties because replication is a key requirement for inferring relationships. More strata therefore require larger sample sizes at greater cost in time and resources.

Area Search Census Instructions

Adapted from a protocol published by Point Reyes Bird Observatory in May 1999
Choosing a plot (or search area): All search areas in a given pairing should be the same size and of the same habitat type. The size of the plot should be such that it can be easily covered and birded thoroughly over a given period, often about 20 minutes, and this is the most useful criteria in setting up the size of your plots. Plots may be of any shape. The different plots may have adjoining boundaries. In general the plot boundaries should be at least 25 meters from edges or different habitats; however this is frequently impossible, especially in riparian habitat, it is usually only the rule for areas containing continuous habitat. Plot boundaries should be planned and marked using permanent geographic features so that they can be relocated in subsequent visits, seasons and years, and often by different observers. These boundaries should be described in detail, and if necessary a map clearly delineating these boundaries and the plots should be made.

We have chosen 7 areas, although not all need to be searched using the time limits in this protocol.

- The paired area survey protocol will be used to compare the three areas delineated in Figure 3, so that we can assess bird use of the differently vegetated banks. Patches of herbaceous bank and shrubby bank of equal size and shape can be paired with a similar size and shape of wooded bank, which represents the site before treatment.
- If desired, another set of paired area surveys could be done, comparing the prairie and the wetland each with the lawn, all of which are roughly similar in size.
- There is no nearby stand of oaks in a lawn to use for comparison with the oak savanna section. Data collected from the savanna need not conform to the time constraints. It will be used for the site inventory and to develop knowledge of the site’s importance for migrants.

Figure 2. Location of area count plots

Figure 3. Habitat map.

Area 1. Herbaceous bank: 70 meters of the north bank bounded on the northwest by a large dead cottonwood; the southeast boundary should be marked, the area extends from the path to the river. See Fig. 2.

Area 2. Shrubby bank: 70 meters of the north bank bounded on the northwest by the above referenced marker; the southeast boundary is the intersection of the path leading to the bridge; the area extends from the path to the river. See Fig. 2.

Area 3. Wooded bank: 70 meters of the south bank beginning at the point where there are trees on both sides of the river; the southeast boundary will be past the bridge and should be marked. See Fig. 2.

Area 4. Prairie: all prairie north of the east-west path and west of the north-south path, as seen in Fig. 3

Area 5. Wetland: as marked in Fig. 3

Area 6. Lawn: all lawn north of the east-west path and east of the north-south path except for the athletic circles, as seen in Fig. 3

Area 7. Savanna: as marked in Fig. 3

Step 6: Design and pilot standardized field protocols that minimize error and bias

Monitoring Objectives matched with Protocols:

Monitoring Objective 1. Assess the population status of species of concern: inventory all species using the prairie, oak savanna, wetland swale and herbaceous/shrubby bank areas in spring, summer and fall.

Protocol: repeated checklists, collected by habitat block (this can coincide with effectiveness monitoring). A species accumulation curve will determine when sufficient data has been gathered. Existing eBird data can serve as a comparison. If additional data is needed after effectiveness monitoring is concluded, consider recruiting local birders to collect checklist data by habitat block in a subsequent year.

Monitoring Objective 2. Monitor effects of conservation decisions on populations of migratory birds which use the riparian area, prairie and wetland as a refuge, and on breeding birds of concern that use small prairies and wet meadows, if they are present. Make comparisons to local reference areas to gauge impacts of conversion to prairie and wetland and removal of riparian woody vegetation.

Protocol: paired area count

Monitoring Objective 3. Monitor trends of species of concern, if warranted. This would be warranted if species of concern are found in the breeding season and are deemed to be appropriate conservation targets for the project, and if the numbers or species composition of migrants are distinctive in comparison to surrounding habitat. This objective is not addressed in the protocols below. If warranted, either of the point count methods found in scenarios 2 and 3 can be used.

Protocol: Not recommended until after inventory is complete, in the case that birds of concern are present. Because the site is small, it will be difficult to establish trends with any statistical accuracy. However, if needed, a few 75m radius points could be established and trends analyzed as described on the bottom of page 34.

Screen and train observers
Simplify survey methods to focus attention on priority species and tasks.
Stratify to minimize site effects
Use standardized methods to control or model survey effects
Account for variation in detection rates, if called for by monitoring objectives
Obtain peer review of protocols
Test protocol and solicit feedback from observers
Use pilot data to establish quantifiable objectives and determine sample size

Observers must be proficient in recognizing birds by sight and sound. Training resources are described in Appendix B. Step 8 below describes the area search protocol in detail.

The area searches which satisfy the monitoring objectives are a simple protocol which should take a little over an hour to complete; however, 6 visits are required. The site is in an urban area and is visited by many birders. Consider recruiting a birder or two to help with the surveying if the number of visits is prohibitive.

Because the site is so small and random sampling is not needed, using pilot data is not necessary.

Step 7: Identify or develop a data management system

Develop project metadata.
Design and curate the database.
Archive and/or exchange your data.
Provide access to data in accordance with legal and proprietary constraints.

In the bird monitoring community, there is an energetic focus on including as much data as possible into national databases where it will be available to other researchers. The Avian Knowledge Network (AKN) is a unified national effort, housed in Cornell Lab of Ornithology, to collect and make available avian datasets. The AKN has several regional nodes across the country: ours is the Midwest Avian Data Center (MWADC). Both provide data storage and analysis and visualization tools. EBird data is incorporated in to the AKN, so all data collected by the BCN via eBird is part of MWADC and AKN. MWADC is adaptable and can accept data from small studies.

For the paired area count study, the MWADC website can serve as a data repository. On this site are analysis tools that can be used to investigate adaptive management questions and the other monitoring objectives. Metadata can be stored there as well.

Step 8: Implement the monitoring program

Prepare for the field
Perform survey
Enter and error-check data
Limited analysis to refine hypotheses

1. Conducting a census:

Each area search plot is covered in the same number of minutes during a census, depending on size of the plots. In this case, ten minutes will suffice. All 7 plots can be covered in a single morning. Surveys should take place between a half hour after sunrise and 9 am. Observers cover the entire plot in the time allotted. Observers are free to stop the area search (and the clock) to investigate songs, calls, or breeding activity. This may be necessary for identifying unfamiliar species.

Carefully record your starting time when you begin, stay aware of the time throughout the census to ensure both good coverage and correct timing, and keep track of any pauses you take in the 10 minutes. With groups it may be helpful to designate one observer as timekeeper. Be sensitive to the subjects of the census and in particular do not stay too long near a nest or anywhere where birds are distress calling.

Use the Area Search Form – Eugene Field Park (Appendix C) to record data, or keep field notes in your preferred manner, such as a notebook or voice recorder. Record the name of each species seen or heard. Other species not obeserved in the 10 minutes, or observed off the plot or flying over the plot and not using the habitat, may be kept on a separate list and entered into the eBird hotspot.

Observers: At least one observer should be able to identify by sight and sound all of the species likely to be encountered. Observers not familiar with the birds, habitat or methods are encouraged to participate as recorders or counters of easily identified species. One or two observers per plot is preferable. During the census, observers should keep together, **act as one observer**, and record all observations on the same sheet by the designated recorder. Consider using multiple teams of observers to allow for detectability analysis

2. Frequency

   All seven plots can be done in a single morning. We recommend at least six visits to each plot, with three censuses of each plot between late April and mid-May and others any time during the migration period of April, May and late August through October. During the breeding season a single census may be adequate although two are preferred.

Step 9: Present results in a format that supports sound management and conservation decisions

Interpret results and prepare reports with your audience in mind
Use knowledge of the surrounding landscape, ecology of the species, and an understanding of the details of the monitoring protocol to provide insight into what drives observed changes. Define the limits to which monitoring data should be applied. Consider your audience and how members of that audience will use the information.
Provide tools that inform management and conservation decisions – Useful tools can include management guidelines, paper maps, GIS data layers, or computer programs that simulate effects of management alternatives.

Step 10: Evaluate and adjust management and monitoring to make better bird conservation decisions

Evaluate the conceptual model
Adjust management if necessary
(include trigger point that would result in management modifications)

Trigger point: bird diversity declines of more than 25% with 80% certainty will trigger three consecutive years of monitoring.

Information about how this type of bank stabilization and lawn conversion impacts migratory and breeding bird populations can be incorporated into future management and shared with other local land managers.

Example 2: Orland Grassland

In this large prairie and wetland restoration, different successive partnerships used several restoration methods. Ten years of citizen science bird monitoring data from the BCN Survey as well as plant data from the Corps staff and contractors and Orland Grassland Volunteers are available. Breeding grassland birds are common. The protocol described takes advantage of the **BCN Survey breeding season point count** and adds additional **repeated point count surveys** for more analysis power**.** This protocol provides for trends analysis and effectiveness monitoring and is appropriate for a situation with more than one observer to allow for repeated visits. It is appropriate for a situation in which there is a need to accurately detect small changes in bird trends.

Background and Introduction

Orland Grassland is a 960-acre Cook County Forest Preserve with more than 750 acres of open prairie in which grassland birds find needed habitat. A large, two-phase restoration has been completed. The area was once farmland but is now being restored as a grassland complex with prairie, wetlands, ponds, oak savannas, shrublands and woodlands. Habitat restoration efforts began in 2002 with the removal of woody species from the interior of the site, aggressive invasives control, and interseeding of appropriate locations in collaboration with a large volunteer group. The project is managed by the Corps, in partnership with the Forest Preserve District of Cook County, Openlands, and the Orland Grassland Volunteers.

In Phase 1, plantings of trees that fragmented the sites's interior were removed, herbaceous weeds were controlled, the former woody areas were planted to native prairie, and volunteers did native seed collection and interseeding into receptive prairie areas.

In Phase 2, completed in summer of 2014, approximately 150 additional acres of invasive trees were removed, and 12.5 miles of drainage tiles were abated. Herbicide was applied to herbaceous cover in locations that were not interseeded in Phase 1 to prepare those locations for planting. Herbicide was omitted from selected sections of woody vegetation removal to allow for shrubland succession. Following these site preparation tasks, about 635 acres of land was seeded using wet prairie, mesic prairie, marsh and wet/mesic prairie seed mixes. In addition, nearly 50,000 native plant plugs were installed across the site.

Step 1: Establish a clear purpose

Define the problem

Problem statements identify the populations of concern within clear boundaries of space and time, as well as the management issues or threats that are believed to limit them. A problem statement also might describe policy, regulatory, or management decisions that could benefit the target species. Include lists of local species of concern status of different local species assemblages, and sources of background information about bird populations at local sites

The topographic relief on this site provides nesting habitat for a wide range of grassland bird species, a suite of avian species of the highest conservation concern in the Chicago Wilderness area.

The FPCC requested that the Corps initiate a study in 2003 to address the generalized problems at the tract, which were identified as
1) reduction in native species biodiversity and abundance,
2) absence of natural community types, and
3) loss of ecosystem functions and processes that create and maintain wetland communities.

Problems & Opportunities

The following are resource problems that have been identified at Orland Tract. Problems which apply to bird populations are bolded:

- Persistence of unnatural local hydrology
- Decline in native species richness of native plant communities
- Loss of native ground cover species through the reduction in light levels
- Reduced reproduction of native trees such as oaks, which require minimum light levels to survive
- Increased soil erosion because of the loss of ground cover species
- **Decline in native species richness and abundance of grassland bird communities**
- **Significant decrease in nesting habitat of moist grassland and other wetland birds**
- Absence of a core buffer area from the urban surroundings
- Degrading effects of non-native and invasive vegetation
- Loss of forage species, especially graminoids and mast producing shrubs
- **Loss of habitat for native fauna**

Pertinent Excerpts from Orland Tract Section 206 Ecosystem Restoration Environmental Assessment May 2006, U.S. Army Corps of Engineers

Significance of Environmental Resources and Degradation

The mix of grassland birds currently using the site is outstanding compared to the rest of the region; however, numbers are slowly declining as habitat deteriorates. The quality and size of the grassland acreage is already at the point of becoming non-supportive for many of the prairie bird species. All prairie bird species require at least 50-acres of contiguous grassland. The Chicago Region Biodiversity Council recommends a minimum of 500-acres for full conservation of grassland bird communities, and Orland Tract meets this criteria. Shrubland, savanna, and woodland are all rare habitats in the Chicago Region as well. Restoration of these as proposed would also yield valuable ecosystem benefits, especially for shrubland bird species such as the Orchard Oriole, Yellow-breasted Chat, Yellow Warbler, and two species of Cuckoos.
…
Special Status Species – … the highest priority grassland bird species on the site are the state-endangered Henslow's Sparrow and the Northern Harrier. Other grassland bird species of importance include Bobolink and Grasshopper Sparrow. Additional grassland birds known from the property include Eastern Meadowlark, Vesper Sparrow, and Savanna Sparrow.
…

Goals

The ecosystem restoration goal of this project is to naturalize the tract's hydrology and restore overall biodiversity and ecosystem function.

Objectives

The following are site-specific objectives of this study for ecosystem restoration at Orland Tract:

Increase species richness of native plant communities
Increase species richness and abundance of grassland bird communities
Increase the nesting habitat of moist grassland and other wetland birds
Provide a buffer from the urban surroundings
Eliminate the ill-effects of non-native and invasive vegetation

Identify and consult stakeholders:

Forest Preserves of Cook County (landowner), U.S. Army Corps of Engineers, Orland Grassland Volunteers, Village of Orland Park, Bird Conservation Network

Set a conservation goal:

Monitoring programs typically aim to assess the population status of one or more species, quantify population trends, identify the effects of environmental changes on populations, or determine the effectiveness of efforts to stabilize or increase populations. It is sometimes possible to achieve all four types of objectives simultaneously.

Status assessment involves measuring the current condition of populations to inform a pressing management or conservation decision and/or establish a baseline for quantifying future change. Related objectives may be to inventory species, describe species-habitat relationships, identify critical habitat, or compare present population size to a desired level.

Trend monitoring calls for surveys to be repeated at the same locations in order to estimate rates of change in status measures (e.g., occurrence, distribution, abundance, vital rates, and/or health).

Effects monitoring uses covariates to link changes in bird populations to changes in the environment. This approach can help explain why populations rise or fall. Monitoring effects also can aid in projecting impacts of development, climate change, and other threats.

Effectiveness monitoring, also known as evaluation, consists of monitoring populations before and after conservation decisions are implemented. This is a critical component of adaptive management, an iterative process that relies on monitoring results to formulate and refine conservation decisions (Walters and Holling 1990).

It is important to make monitoring objectives specific and quantifiable. They may start out broad, but should be sharpened after a partnership is formalized and pilot data are available.

The bird conservation goals we propose are:
Large: On a rich mosaic of grassland and wetland habitat types, increase abundance and species richness of total numbers birds of concern in the breeding, migration and winter seasons
Medium: When compared to pre-Phase 1 and pre-Phase 2 levels: increase abundance and to maintain species richness of grassland birds of concern, and maintain species richness of the shrubland species of concern.
Small: When compared to pre-Phase 1 and pre-Phase 2 levels: maintain abundance and species richness of grassland birds of concern, and maintain species richness of shrubland species of concern.

The monitoring objectives we propose are:

Monitoring Objective 1. Monitor trends of breeding grassland and shrubland species of concern.

Monitoring Objective 2. Monitor effects of conservation decisions on populations of birds that use the prairie and shrubland areas.
Specifically, monitor the effects on grassland birds of including tall grasses in the restoration seed mixes.

Monitoring Objective 3. Assess the population status of migratory and wintering species of concern: inventory all species using the site in spring, summer, fall and winter.

Another objective that might be considered in the near future is determining the effects on shrubland birds of mowing and not herbiciding woody vegetation on the perimeter in order to establish a shrubland rotation. The method described for monitoring objective 2 could be used.

Step 2: Determine whether an existing program or protocol meets your needs.

The site is well covered by BCN Survey point counts, and the Orland Grassland Volunteers have a wealth of inventory data. As Orland Grassland is a popular place to bird, eBird also has much data. The protocols we suggest incorporate these valuable resources.

Include description of existing programs and protocols
Build on monitoring assets that are fundamentally sound – to assess the suitability of a monitoring program, you can use the online monitoring evaluation tool developed by Southeast Partners in Flight (http://evaluation.sepif.org/index.html).
Form or join a monitoring partnership
Include people with quantitative skills
Define roles of partners

Bird Monitoring programs in the Chicago Wilderness area:
BCN Survey: site-based feedback for land managers; point counts and transects
Northeast Illinois Wetland Study: monitoring wetland bird populations across NE Illinois; uses national protocol
HMANA Hawk Counts: Illinois Beach State Park, Greene Valley Forest Preserve, Fort Sheridan
Critical Trends Assessment Program: statewide biodiversity trends monitoring
MOON Monitoring of Owls and Nightjars in Illinois
Monitoring partnership: Midwest Coordinated Bird Monitoring Partnership
Potential Quantitative Analysis Partners: Midwest Avian Data Center (Point Blue Conservation Science), Field Museum, Prairie Research Institute, Lincoln Park Zoo Urban Wildlife Institute, USGS Lake Michigan Ecological Research Station, land management agencies, biological contractors, UM/GL Joint Venture, LCCs
Banding Studies: inquire of an officer at http://www.ibbainfo.org/home.html, or on the banders' listserv http://www.lsoft.com/scripts/wl.exe?SL1=BIRDBAND&H=LISTSERV.KSU.EDU
Demographic Studies (nest searches): area academic institutions. These are often done by grad students and/or professors, and are linked to a research question of academic interest.

Step 3: Assemble a team of collaborators with complementary interests and skills

affiliation	title	role
Army Corps	ecologist	oversee project, collect data
FPCC	landowner	oversee project
Bird Conservation consultant	consultant	develop protocol, recruit volunteers, oversee data collection, collect data
Orland Grassland Volunteers, BCN	monitors	collect data
Lincoln Park Zoo Urban Wildlife Institute	consultant	quantitative analysis

Step 4: Summarize the relationship of target populations to other ecosystem elements, processes, and stressors

Summarize life history information for the species or species group of interest

(Adapted from Heaton, 2003 and Pollock, 2007)
In Illinois, there have been dramatic declines in grassland birds. During the 25-year period ending in 1984, grassland songbirds (e.g., Henslow's Sparrows, grasshopper sparrows, savannah sparrows, bobolinks, eastern and western meadowlarks, and dickcissels) in Illinois declined by

75 - 95% (Illinois Wildlife Habitat Commission, 1985), thought to be due mainly to changes in agricultural practices. Since then, population numbers for most species have stabilized at those low levels, and Henslow's sparrow numbers have recovered somewhat. Grassland bird habitat throughout the Chicago Region has been subject to threats, resulting in a decrease in species richness and abundance due to disrupted hydrology, invasive species, lack of fire and fragmentation.

Grassland birds will breed successfully in diverse native prairies and in fields of Eurasian grasses. Some early prairie restorations consist of monocultures of tall grasses such as big bluestem and Indian grass or fields dominated by aggressive forbs such as stiff goldenrod and grey-headed coneflower, and are little used by most prairie bird species. However, these seed mixes establish easily and are inexpensive.

Vesper and grasshopper sparrows nest in shorter grasses with more bare soil, while Henslow's sparrows and sedge wrens prefer taller grasses. Bobolinks prefer a medium litter layer, while eastern meadowlarks and most notably Henslow's sparrows use the high litter associated with a few years without burns. The habitat requirements of grassland birds are diverse (Sample and Mossman, 1997).

Some species of grassland birds are area-sensitive and will nest only in large grasslands. For example, Henslow's sparrows, savannah sparrows, and bobolinks are highly sensitive, and need large blocks of grassland, but field sparrows, song sparrows, and common yellowthroats are less sensitive to area, and will nest in smaller grasslands (Herkert et al., 1993). Managing for large tracts of grassland habitat is the best strategy for supporting viable populations of grassland birds. Large sites have the advantage of accommodating the needs of species requiring large areas (i.e., area-sensitive species) as well as those that do not (Sample and Mossman, 1997).

Many area-sensitive species will not nest even in large grasslands if too many small trees or shrubs are present. In sites where fire has been absent for many years, grasslands are overtaken by scattered shrubs and trees of various species, both native and exotic. In most cases, woody cover over 1 meter high in the central grassland area should be kept to a maximum of 5% for obligate grassland species (Sample and Mossman, 1997). (Scattered shrub cover can be maintained for shrubland bird habitat if the site is large enough to have a core of contiguous grassland habitat that is 250 acres or larger for healthy grassland bird poulations.) This guideline has been successfully implemented on many Chicago area sites to increase grassland bird populations. Ground-nesting grassland birds usually avoid nesting within 50 or 100 meters of woody vegetation (especially treelines and woodland edges). Prime grassland bird nesting habitat begins at about 100 meters from trees and dense shrubs.

Build a conceptual model (hypothesis) – A conceptual model is "a hypothesis regarding the expected response of a species or species group to changes in environmental conditions and/or management" (Vesely et al. 2006). This type of model uses written descriptions and/or diagrams to depict cause-and-effect relationships among ecosystem elements, natural processes, and anthropogenic stressors. Conceptual models may be created through hand drawings or flowchart tools available in most office software packages, or by using systems modeling (e.g., Stella) and workflow software (e.g., Kepler).

Table 2. Hypothesized Changes in Abundance and Species Richness

Habitat changes	**Expected response of species groups**	**Net changes to species richness**	**Net change in abundance/diversity of species of concern**
Conversion of additional acreage to prairie by clearing woody invasives	Grassland birds expand nesting and wintering area	Species richness remains the same in breeding season and increases in winter	Abundance increases in both seasons
Reduction of woody vegetation, particularly woodland patches and invasive shrubs, in shrubland areas	Some shrubland birds no longer return to nest or nest in fewer numbers; others nest in greater numbers	Species richness stays the same or decreases in the breeding season	Abundance of breeding shrubland species of concern decreases; no change or decrease in species richness
Establishment of diverse prairie habitat not dominated by tall grasses or aggressive forbs	Increased diversity and abundance of grassland birds	Species richness increases in the breeding season	Abundance and diversity of species of concern increase

Identify important response variables and covariates to monitor **–** Primary response variables will be those parameters of greatest interest based on the conceptual model. They could include variables such as density, seasonal survival, or nest success. To ensure a focused survey design, limit the list of primary response variables, but consider incorporating secondary response variables that can be measured efficiently. This is also a good time to identify covariates known or suspected to affect the target populations. Examples of covariates that may have a direct influence on birds include temperature, precipitation, vegetation structure, food availability, and the abundance of predators. Examples of covariates that may have an indirect influence on birds include elevation, slope, and land use activities that change the context of the sampled locations within the surrounding landscape.

Response variables: bird density, density of birds of conservation concern, presence or absence of bird species
Habitat Use Covariates: habitat type, date, bird species, seed mix used
Detection Covariates: observer, weather factors (wind direction, storms), time of day

Revisit conservation and monitoring objectives

Same as above.

Step 5: Develop a statistically robust approach to sampling and data analysis

Identify appropriate analytical procedure

In the most general of terms, adaptive management is a structured, iterative process of decision making where information is collected along the way to better influence future management decisions. When applying this process to the management of wildlife habitat, it is necessary to determine how species within a habitat (or multiple habitats) are influenced by management decisions. To do so, data is often collected from a random subset of locations within an entire habitat to infer properties about the whole population, the basis of statistical inference. When deciding upon a proper protocol to collect and analyze data, it is important to ask a number of questions before going out and collecting data:

1. What is the size of the habitat? Is it feasible to survey the entire area?
2. What types of patterns or processes am I interested in measuring? What type of data would provide the best measurement?
3. If I am trying to determine differences between groups of sites managed in varied ways, how small of a difference am I interested in detecting?
4. What types of birds am I interested in monitoring (e.g. breeding birds, birds during migration, etc.)?

All of these questions will influence study design and statistical analysis. Below, we provide a statistically robust approach for larger sites such as Orland Grassland, specifically addressing the questions above. This approach can be used to collect the information necessary for an adaptive management decision making process to address Monitoring Objective 2, and will also allow for analyzing trends in bird populations over time and add data to a site survey.

Orland Grassland is too large to count in its entirety and will require a sample of a subset of locations within each habitat to determine how different management practices influence the bird community. The large size of this site allows for robust analytical methods that can detect small changes. Given that point counts are already being conducted at Orland Grassland by the BCN, there exists an opportunity to incorporate those data with additional data collected by Corps staff to increase sample size and therefore analytical power. Depending on the management question, additional sites (points) may be required. For example, to study how grassland species are affected by the elimination of tall grass from seed mixtures, if there are very few BCN points at Orland that have been managed in such a way, then randomly selecting and sampling more sites that where tall grass has been eliminated from the seed mixtures will be important in order to make robust comparisons. For management decisions that are discrete choices (e.g. plant seed mix A or B), an experimental design with treatment level effects and controls is preferred. For every management related question, it is important to select sites that have been managed in different but discrete ways to determine the effect of a management style (e.g. management style A vs. management style B vs. control).

Accounting for imperfect detection in your analysis

The variables we are most interested in (e.g. abundance, occupancy, etc.) are not directly observable because individuals can be overlooked during a count (in other words, the probability of detecting an individual is < 1). When making direct inference from the collected data (i.e. raw observations) where detection probability is < 1, we introduce bias that reduces estimates of species diversity (Schmidt 2005), population estimates (Royle and Nichols 2007)
, and survival probabilities (Nichols and Pollock 1983). This is especially of concern for rare species, such as several grassland species of conservation concern. For example, consider a study where counts are conducted for Henslow's sparrows at two locations (A and B), and more

sparrows are counted at location B. This can mean one of two things: either there are more birds in location B or birds are easier to detect in this location (perhaps due to dense vegetation at location A). Without properly accounting for detectability in an analysis it is difficult to make proper inferences regarding current management practices, which can adversely influence future management decisions.

In order to account for issues with detectability, sites are often revisited multiple times to create an ‘encounter history’ for a single species at a location. These data can be used to separate the observation process (issues with detectability) from the state process (abundance, occupancy, etc.) and allow for more robust inference. However, there are trade-offs that occur when using a design such as this because repeated visits are often at the cost of adding additional points. There are other frequently recommended methods of accounting for detectability including distance sampling and double observer. Due to the availability of BCN monitors at this site and the recent studies showing that distance estimation is often subject to error (Alldredge et. Al. 2007), we chose the repeated point count method.

Two simple steps are necessary to decrease variability in the observational process for bird surveys, thereby making it easier to estimate the variables we are actually interested in (e.g. abundance, occupancy, the influence of different management practices, etc.) One is taking the time to properly train and test field technicians on how to identify birds by sight and song. The other: do not conduct counts in weather conditions that interfere with the ability to detect birds, as bad weather will introduce heterogeneity in detection probabilities.

Delineate the sample frame; stratify for various habitat features. Restrict the stratification of a sample frame to a small number of properties because replication is a key requirement for inferring relationships. More strata therefore require larger sample sizes at greater cost in time and resources.

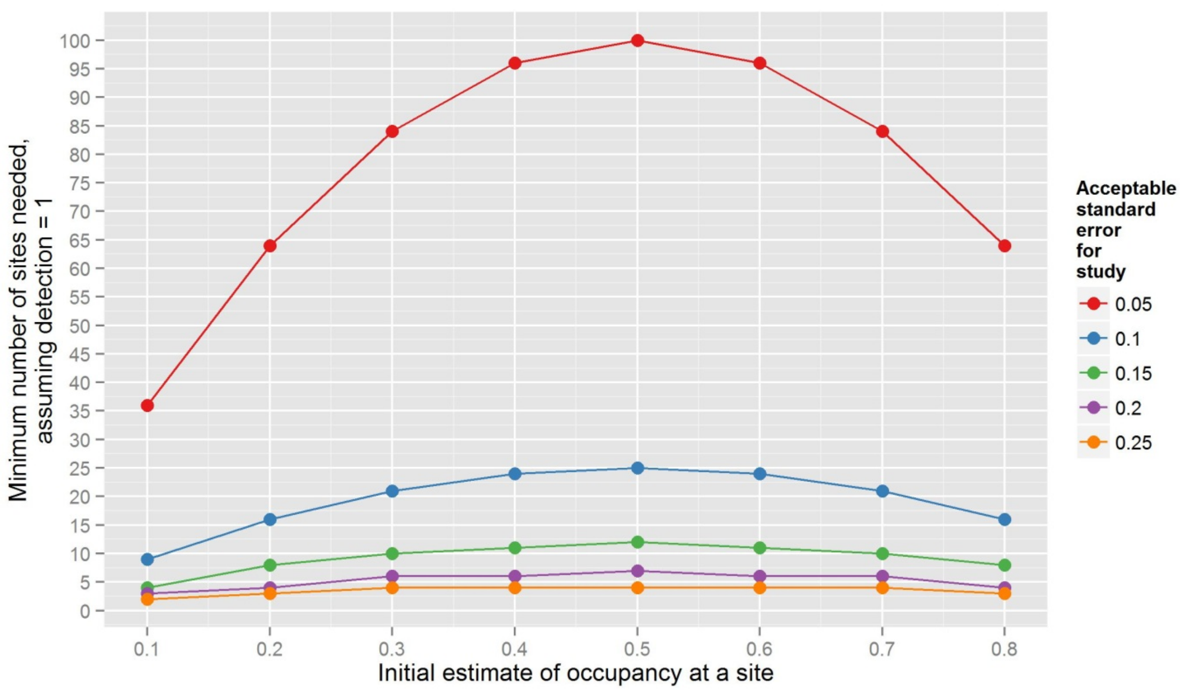
Determining how many sites and surveys are necessary

Explicitly defining a study site is critical for any field study. At times, boundaries can be naturally occurring if a habitat type is discrete, such as a pond or fragmented forest stand. Conversely, sites can be defined arbitrarily if the habitat type lacks discrete boundaries (e.g. 1 acre blocks within a grassland). Because we are interested in how management practices influence grassland dependent bird species, it makes the most sense to define sites in arbitrary terms. Because we are conducting point counts, a site is simply defined as location where a point count occurs. Furthermore, point counts must be sufficiently far enough away from each other so that they are independent.

The number of sites (points) that are needed for a study will depend on a number of factors which include:

1. How accurate you want the estimates to be
2. How rare a species is
3. How easy a species is to detect
4. The maximum number of surveys that can be done (due to resources, availability, etc.)

Initially, it is useful to estimate the number of sites necessary while assuming a detection probability is 1 (in other words, if the bird is present, it will always be observed.) This can be very helpful as it represents a 'best-case scenario' for a study and establishes the minimum number of sites that need to be surveyed. Here, we consider accuracy in terms of the standard error associated to an estimate. The smaller the standard error the more accurate the estimate. Standard errors can be quickly converted to 95% confidence intervals by multiplying the standard error by 1.96. For example, if we want very accurate estimates a standard error of 0.05 may be acceptable, and the associated 95% confidence intervals would be about ± 0.1. Given this standard error, we would be able to determine fine-scale differences between management types if they do exist (at the ± 0.1 level). Below, we plot out the minimum number of sites necessary at varying rates of site occupancy and at different levels of precision in our results (Fig. 1). If less precision in the results is needed, the number of sites necessary is dramatically reduced. If at all possible, we suggest having a minimum of at least 15 points for each management level effect (e.g. 15 control sites, 15 managed sites) in order to accurately determine differences between them. Collecting pilot data can be useful as well, as those data can generate initial occupancy estimates, using the chart below.



Knowing how many points are needed is a critical first step, but we must also determine how many times they need to be surveyed in order to account for issues with detectability. To do so we need a general idea of how detectable a species may be and how rare it is. If observers are properly trained, the probability of detecting a singing grassland bird is quite high during the breeding season. This minimizes the number of surveys necessary to deal with issues of detectability. Table 1 shows how many visits are needed for different detection probabilities (how readily a species is detected) and probability of occupancy (the likelihood that a species is present). When detection probability is high (≥ 0.5), as it is in the case of many breeding birds, only 2 to 3 surveys are necessary at each site (Table 1). When detection probability is low, however, more surveys are necessary for more common species (i.e. high occupancy rate, low detection probability) than for rare species (i.e. low occupancy rate, low detection probability). This may seem counterintuitive, however, what this table implies is that when a species is rare (low occupancy rate) and hard to detect expending additional effort within a site to detect a species is not a sufficient use of resources because the likelihood of its presence is low. Conversely, common species that are difficult to detect require more surveys because all points are very likely to contain the species. Regardless, this will not likely be an issue for most breeding grassland species: as long as observers are able to identify species by sound, detection probability is high. For Orland Grassland we suggest surveying points a minimum of 3 times.

Table 1. Optimum number of surveys to conduct at each point for a standard design where all sites are surveyed an equal number of times for selected values of occupancy and detection probabilities. Site occupancy signifies the probability that an individual is present at a specific location.

	Probability of Occupancy								
Detection probability	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.1	14	15	16	17	18	20	23	26	34
0.2	7	7	8	8	9	10	11	13	16
0.3	5	5	5	5	6	6	7	8	10
0.4	3	4	4	4	4	5	5	6	7
0.5	3	3	3	3	3	3	4	4	5
0.6	2	2	2	2	3	3	3	3	4
0.7	2	2	2	2	2	2	2	3	3
0.8	2	2	2	2	2	2	2	2	2
0.9	2	2	2	2	2	2	2	2	2

Source: Mackenzie et al. 2006, pg. 168

In summary, our general suggestion for a study is that you would need 15 sites per discrete management type plus 15 unmanaged 'control' sites that are surveyed at least 3 times by any combination of qualified observers including BCN monitors. For example, to determine how a tall grass seed mixes influence breeding birds a total of 30 sites would be needed, 15 of each type (i.e. 15 tall grass sites, 15 control sites), and each site would be surveyed 3 times. Thus, in order to account for issues with detection probability a maximum of 90 point counts would need to be conducted.

In the event that not enough resources are available to account for detection probability

While accounting for imperfect detection is preferable, there are times when resources simply do not allow for repeat surveys. In the event that resources are not available, there are less robust analyses that can be performed, and the type of analysis used depends upon the variable you are interested in tracking. For site occupancy, species presence-absence data can be analyzed using logistic regression. Similar to occupancy modeling, species presence is coded as a '1' while species absence is coded as a '0'. Where these two methods differ is that instead of creating an encounter history at a site, with repeated surveys, sites are only visited once. These data can then be modeled using logistic regression analysis, yielding information about areas were birds are likely present or not present. Covariates can be included in this analysis. However, detectability cannot be determined using this method. If you feel that detectability will have a strong influence on results (in other words, in situations where it is difficult to detect the species that you are sampling), don't use this method or interpret the results with caution.

The actual count data can be analyzed as well, in order to determine trends or make comparisons between treatments. For count data, a useful starting place is Poisson regression analysis (a form of regression analysis used to model count data), as the Poisson distribution typically fits count data. However, after assessing model fit, it may be necessary to use a negative binomial or zero-inflated Poisson regression if the data are overdispersed (i.e. there is greater variability in the data than expected based off the model used). Regardless of the technique used, each species will be analyzed on its own (i.e. univariately). Below, we provide an example of what a data frame would look like for logistic regression (a statistical method for analyzing a dataset in which the dependent variable is binary and there are one or more independent variables that determine an outcome) or Poisson regression (Table 2).

Table 2. Example data frames for a single species logistic regression or Poisson regression analysis

Analysis type	Species	Treatment
Logistic regression	1	control
Data type = binary	0	control
	0	Tall grass
	1	control
	0	Tall grass
Poisson regression	2	control
Data type = count	0	control
	0	Tall grass
	4	control
	0	Tall grass

Midwest Avian Data Center (MWADC): an online data storage and analysis option

MWADC is a free data storage and analysis site whose goal is to make timely and relevant scientific data and analyses readily accessible to habitat managers, conservation practitioners, scientists, and the public. Land managers may want to consider using it to store and analyze project data. It is located at http://data.prbo.org/partners/mwadc/. For habitat managers and conservation practitioners, the latest interpretations of data as they apply to geographic areas and jurisdictions are available to derive trends, indices of density and abundance, interactive maps, and other visualizations from the collective data sources of participating partners. For scientists, data are collected, stored, and made available so that research questions can be answered collaboratively and accurately at different scales.

Different treatments can be assigned to groups of points, and birds can be assigned to different guilds, in order to answer many questions, including those in this example. The site's analysis functions could be used to analyze changes in grassland and shrubland bird populations over time (Monitoring Objective 1), and to compare the two treatment groups for adaptive management (Monitoring Objective 2).

Determine an appropriate method for selecting sample units. Standard approaches include simple or stratified random sampling, systematic sampling, and cluster sampling.
For cause-and-effect monitoring, the sampling design should include replicates of the management action, if possible, and replicates of sites without implementation of management practices (i.e., controls). This replication is necessary to isolate, as much as possible, the management action as the only difference among treatment and control sites. (Consider desired levels of precision and power to detect change; consider spatial and temporal scope of inference.)

Sample unit selection for monitoring objectives

Monitoring Objective 1. Monitor trends of breeding grassland and shrubland species of concern.

Monitoring Objective 2. Monitor effects of conservation decisions on populations of birds that use the prairie and shrubland areas, specifically the effects on grassland birds of including tall grasses in the seed mixes.

(Another objective that might be considered in the near future is determining the effects on shrubland birds of mowing and not herbiciding woody vegetation on the perimeter in order to establish a shrubland rotation. The method described here could be adapted to this objective.)

Protocol for Objectives 1 and 2: repeated point counts. This protocol will allow for the assessment of conservation decisions, and will assess site trends, as the number of points required for the effectiveness monitoring cover the entire site.

Determining the effects on grassland birds of including tall grasses (big bluestem, Indian grass and switchgrass) in the seed mixes requires 30 sites or points: 15 in areas that were planted with the tall grasses included and 15 in areas that were planted with seed mixes that did not include tall grasses. Volunteers identified remnants of native vegetation on the site and planted them with seed mixes that did not include tall grasses; the rest of the site was planted with a seed mix that included tall grasses. Figure x shows the outlines of these remnants and the locations of the existing BCN points (yellow circles). Nine of the BCN points (marked with a T) have some significant portion of remnant and are in grassland areas. Points N2 and C1, although they are in remnant areas, are adjacent to sites that were formerly woodland and the grassland has not recovered significantly to attract grassland birds; thus they were eliminated. Six Additional points (marked with an A) can be added to make up 15 points in areas that do not have tall grasses in the mix. Fifteen points in grassland areas that received the tall grass seed mix are marked with a check.

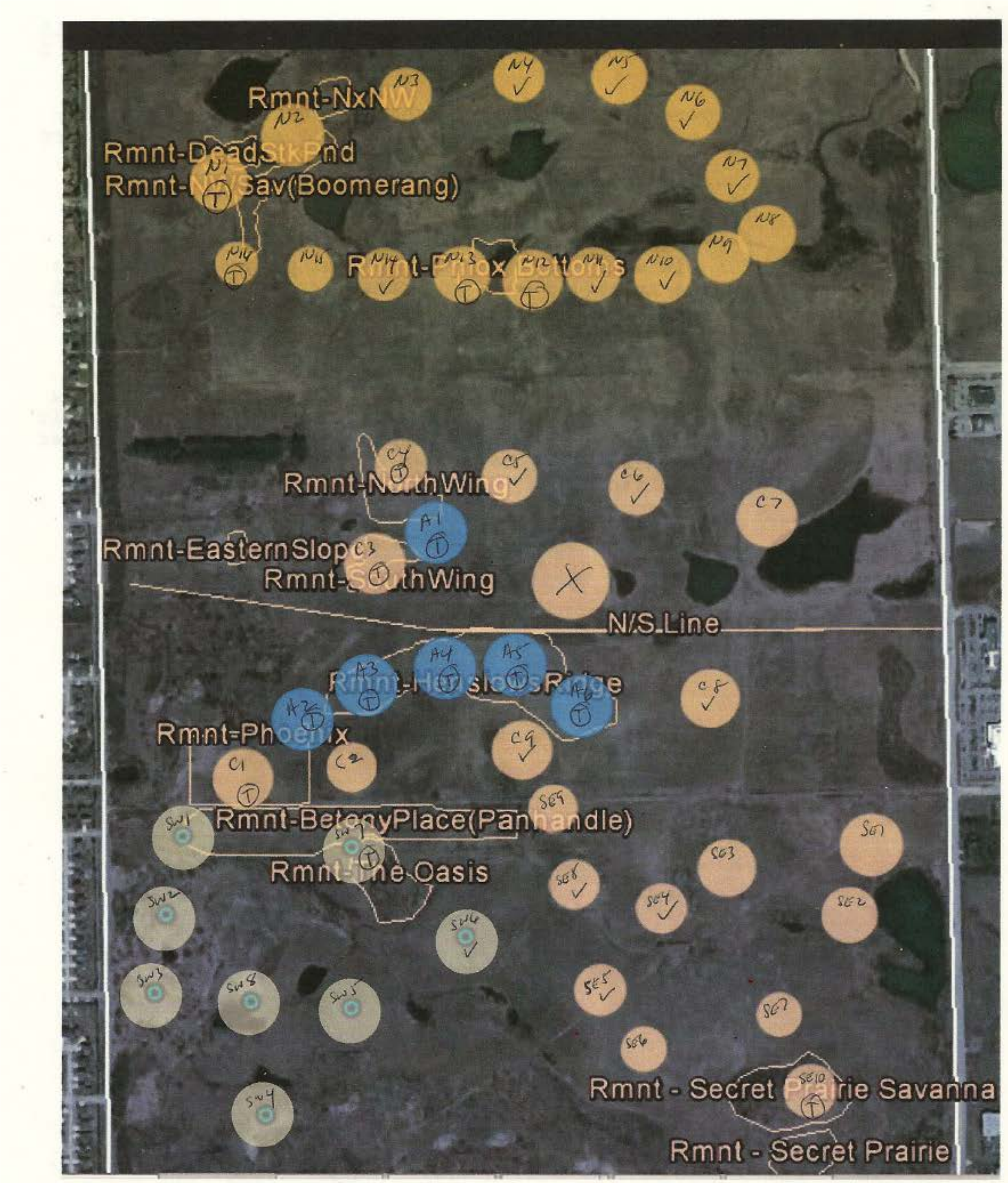


Figure 4. Orland Grassland Monitoring Points
Yellow outlines = remnants planted with seed mixes that did not include tall grasses
Yellow circles = existing BCN points (Labeled e.g. SW5, C9, N3)
T = have some significant portion of remnant and are in grassland areas.
Check = grassland points that received the tall grass seed mix.
Blue circles (A) = Additional points in areas that do not have tall grasses. (Labeled e.g. A2)
X = disregard

Monitoring Objective 3. Assess the population status of migratory and wintering species of concern: inventory all species using the site in spring, summer, fall and winter.

In this case, the sampling unit is the entire site. A combination of existing data can be used to assemble the inventory:

1. BCN data: point count monitoring during June at 43 points
2. Orland Grassland Grand Birding Experience results – an extensive all-site inventory performed annually in May for 8 years
3. eBird data: data entered by birders at any time
4. Orland Grassland Volunteers site surveys – bird and vegetation data collected in habitat blocks

Protocol: repeated checklists, including all existing BCN, Orland Grassland Volunteers and eBird data deemed to be reliable. A species accumulation curve can determine whether or when sufficient data has been gathered.

Step 6: Design and pilot standardized field protocols that minimize error and bias

Screen and train observers
Simplify survey methods to focus attention on priority species and tasks.
Stratify to minimize site effects
Use standardized methods to control or model survey effects
Account for variation in detection rates, if called for by monitoring objectives
Obtain peer review of protocols
Test protocol and solicit feedback from observers
Use pilot data to establish quantifiable objectives and determine sample size

Observers must be proficient in recognizing birds by sight and sound. Training resources are described in Appendix B.

The protocol used for objectives 1 and 2 will be the BCN point count described in Step 8 below. BCN points were randomly located at least 150 meters apart and are at least 200 meters from the edge of the site.

Objective 3 likely does not require more data gathering, merely assembly of data.

Step 7: Identify or develop a data management system

Develop project metadata.
Design and curate the database.
Archive and/or exchange your data.
Provide access to data in accordance with legal and proprietary constraints.

BCN point count data is entered into www.eBird.com/bcn. This allows it to be used for regional trends analysis and makes it available to requests from researchers, land managers, stewards, and other conservationists. A project manager can contact bcnbirds@gmail.com to arrange for a password and user name, or see Appendix D. BCN data can be downloaded from eBird and uploaded to the MWADC website, where analysis tools described above can be used to investigate the adaptive management questions and the other monitoring objectives.

Step 8: Implement the monitoring program

Prepare for the field season
Perform survey
Enter and error-check data
Limited analysis to refine hypotheses

In the bird monitoring community, there is an energetic focus on including as much data as possible into national databases where it will be available to other researchers. The Avian Knowledge Network (AKN) is a unified national effort, housed in Cornell Lab of Ornithology, to collect and make available avian datasets. The AKN has several regional nodes: ours is the Midwest Avian Data Center. Both provide data storage and analysis and visualization tools. EBird data is incorporated in to the AKN, so all data collected by the BCN via eBird is part of MWADC and AKN. MWADC is adaptable and can accept data from small studies.

The following point count protocol is adapted from Ballard et.al, 2003
Before your field day assemble the following items:

binoculars
watch which indicates seconds
waterproof boots (knee-high rubber boots are good for reducing ticks)

And one of the following (listed in order of ease of use):
A voice recorder OR
at least 2 pens and a field notebook
(with either of the two above you can take notes and enter them directly into eBird – just remember to record the time you start), OR
sufficient blank data forms, clipboard, rubber bands for holding forms on clipboard. A data form is provided in Appendix D, although many prefer not to use it.

Depending on the route, census type, and your experience level, you may also need:
directions and maps
GPS unit & extra batteries
cell phone
field guide
water and snacks
hat, sunscreen, insect spray

Breeding season point counts can begin at 15 minutes after local sunrise and must be completed before 9 AM.

We recommend 3 visits per season, in June and early July. Visits should be at least 7 days apart. The BCN Survey monitors normally do two of these visits.

When possible, the order in which points are surveyed should vary between visits. Ideally, observers should also vary among visits.

Do not conduct surveys during weather conditions that likely reduce detectability (e.g., high winds or rain). If conditions change for the worse while doing a count, remaining points can be completed <7 days from the first day.

Approach the point with as little disturbance to the birds as possible, and wait 1 minute to begin your count.

BCN point counts are 5 minutes duration at each point. If something interferes with your ability to detect birds during the 5-minute count, stop the count until the disturbance has passed and start over. Cross out the interrupted data.

Every adult bird detected within 75 meters of a point is recorded and the species and number of birds observed is tallied. Include birds flying below canopy level, flying from one perch to another, or actively foraging on or above the study area.

Birds that are flying over but not using the habitat in the point count area are not included in the point count We recommend keeping a list of all species detected between points (i.e., not during the 5 minute counts) on the back of your form or in your notebook. Juveniles and fly-overs can be listed along with the species seen between points and entered into eBird as Incidental sightings.

Make every effort to avoid double counting individuals detected at a single point. No attracting devices, recordings, or “pishing” should be used.

Step 9: Present results in a format that supports sound management and conservation decisions

Interpret results and prepare reports with your audience in mind
Use knowledge of the surrounding landscape, ecology of the species, and an understanding of the details of the monitoring protocol to provide insight into what drives observed changes. Define the limits to which monitoring data should be applied. Consider your audience and how members of that audience will use the information.
Provide tools that inform management and conservation decisions – Useful tools can include management guidelines, paper maps, GIS data layers, or computer programs that simulate effects of management alternatives.

Step 10: Evaluate and adjust management and monitoring to make better bird conservation decisions

-Evaluate the conceptual model
Adjust management or monitoring if necessary
(include trigger point that would result in management modifications)

Trigger point: Occupancy of any grassland or shrubland species of concern declines by 40% in a given year should trigger management review, consideration of management modifications and two more consecutive years of monitoring

Population trends gathered via the effectiveness monitoring should offer guidance about including tall grasses in the seed mix.

Example 3: Hypothetical large grassland without existing bird data

In this example, we describe a standardized protocol that was published by the US Fish and Wildlife Service in 2008, *Landbird Monitoring Protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions, Version 1*. It was developed "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." The protocol described is **point counts with distance sampling and time removal.** This protocol:

- incorporates current thinking about analysis methods in that it allows for estimation of detection probabilities
- can be used to monitor abundance, density, occupancy and species richness of breeding landbirds
- reflects a current discussion in the scientific literature about the degree to which differences in the ability to detect a species (due to observer ability, time of day, traffic noise, bird behavior, etc.) affect conclusions about trends
- addresses a range of monitoring needs faced by local land managers
- would be appropriate in sites where a trained biologist or monitor is available and which has no history of standardized monitoring
- provides for trends analysis and effectiveness monitoring (which can be used for adaptive management)
- is appropriate for one observer who is expert at recognizing birds by ear and estimating distances to birds upon hearing songs and calls
- yields some meaningful results in one visit although multiple visits allow for the use of more powerful analysis tools.

There is a handbook with extensive advice which we recommend using (Knutson et. al., 2008). It contains 11 Standard Operating Procedures that address the different steps of the process, shown in Figure 5 below. We have adjusted the format of this section to allow for the use of the handbook.

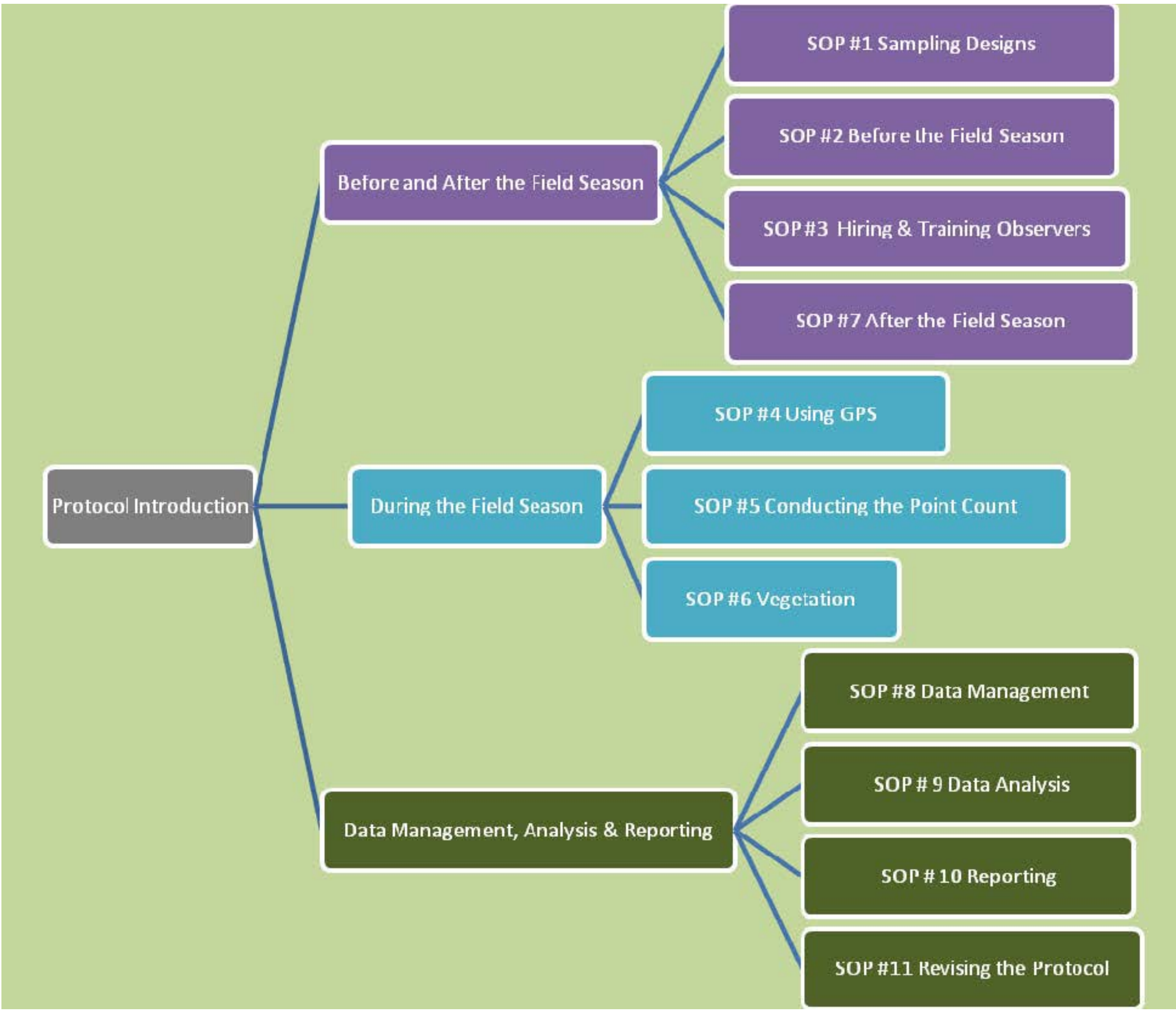


Figure 5. Organization of *Landbird Monitoring Protocol For the U.S. Fish and Wildlife Service, Midwest and Northeast Regions, Version 1*

Background and Introduction

This 250-acre hypothetical grassland restoration project is in the planning stages. It is old field habitat on a mix of dry, mesic and wet mesic soils. It has a small population of meadowlarks, dickcissels and savanna sparrows. Several clumps of scattered woody vegetation have encroached on 75 acres, fragmenting the habitat, and another 50 acres have recently been invaded by tall goldenrod.

Step 1: Establish a clear purpose

Define the problem

Invasive woody and herbaceous vegetation have degraded grassland bird habitat on the site and grassland bird populations are small.

Identify and consult stakeholders: **landowner, neighbors, local birding organizations**

Set a conservation goal

The conservation goal of the hypothetical project is to restore native vegetation and increase bird abundance and diversity in a 250-acre grassland

The bird conservation goals we propose are:
Large: When compared to pre-restoration levels: to increase abundance, distribution and species richness of breeding and wintering grassland birds of concern.
Small: When compared to pre-restoration levels: to increase abundance and distribution and to maintain species richness of breeding grassland birds of concern

The monitoring objectives and protocols we propose are:

Objective 1. Assess the population status of breeding and wintering species of concern: inventory all species using the site in summer and winter.
Protocol: accumulation of checklists and other data, including all existing eBird and other birder and biologist data deemed to be reliable. If this is a site without much existing bird data, the point count protocol described below, with the addition of a few winter visits, can be used to develop an inventory. A species accumulation curve will determine when sufficient data has been gathered.

Objective 2. Monitor trends of breeding grassland species of concern.
Protocol: point count surveys with distance sampling and time removal

Objective 3. Monitor effects of conservation decisions on populations of grassland birds that use the prairie areas; specifically:
- timing of tall goldenrod mowing or
- Woody species control

Protocol: Same as above; sample design reflects stratified points.

Step 2: Determine whether an existing program or protocol meets your needs.

Although there are many partners available in the Chicago Region, for the sake of this example we will assume that the agency has a trained biologist or monitor, a need to detect quite small changes in density and species richness while accounting for detection probability, and an interest in making interagency comparisons with other land managers who are using the same protocol.

Step 3: Assemble a team of collaborators with complementary interests and skills

affiliation	name	role
biologist		Collect data
biologist		Analyze data
Land manager		Management decision maker

Step 4: Summarize the relationship of target populations to other ecosystem elements, processes, and stressors

(Adapted from Heaton, 2003 and Pollock, 2007)
In Illinois, there have been dramatic declines in grassland birds. During the 25-year period ending in 1984, grassland songbirds (e.g., Henslow's Sparrows, grasshopper sparrows, savannah sparrows, bobolinks, eastern and western meadowlarks, and dickcissels) in Illinois declined by 75 - 95% (Illinois Wildlife Habitat Commission, 1985), thought to be due mainly to changes in agricultural practices. Since then, population numbers for most species have stabilized at those low levels, and Henslow's sparrow numbers have recovered somewhat. Grassland bird habitat throughout the Chicago Region has been subject to threats, resulting in a decrease in species richness and abundance due to disrupted hydrology, invasive species, lack of fire and fragmentation.

Grassland birds will breed successfully in diverse native prairies and in fields of Eurasian grasses. Some early prairie restorations consist of monocultures of tall grasses such as big bluestem and Indian grass or fields dominated by aggressive forbs such as stiff goldenrod and grey-headed coneflower, and are little used by most prairie bird species. However, these seed mixes establish easily and are inexpensive.

Vesper and grasshopper sparrows nest in shorter grasses with more bare soil, while Henslow's sparrows and sedge wrens prefer taller grasses. Bobolinks prefer a medium litter layer, while eastern meadowlarks and most notably Henslow's sparrows use the high litter associated with a few years without burns. The habitat requirements of grassland birds are diverse (Sample and Mossman, 1997).

Some species of grassland birds are area-sensitive and will nest only in large grasslands. For example, Henslow's sparrows, savannah sparrows, and bobolinks are highly sensitive, and need large blocks of grassland, but field sparrows, song sparrows, and common yellowthroats are less sensitive to area, and will nest in smaller grasslands (Herkert et al., 1993). Managing for large tracts of grassland habitat is the best strategy for supporting viable populations of grassland birds. Large sites have the advantage of accommodating the needs of species requiring large areas (i.e., area-sensitive species) as well as those that do not (Sample and Mossman, 1997).

Many area-sensitive species will not nest even in large grasslands if too many small trees or shrubs are present. In sites where fire has been absent for many years, grasslands are overtaken by scattered shrubs and trees of various species, both native and exotic. In most cases, woody cover over 1 meter high in the central grassland area should be kept to a maximum of 5% for obligate grassland species (Sample and Mossman, 1997). (Scattered shrub cover can be maintained for shrubland bird habitat if the site is large enough to have a core of contiguous grassland habitat that is 250 acres or larger for healthy grassland bird poulations.) This guideline has been successfully implemented on many Chicago area sites to increase grassland bird populations. Ground-nesting grassland birds usually avoid nesting within 50 or 100 meters of woody vegetation (especially treelines and woodland edges). Prime grassland bird nesting habitat begins at about 100 meters from trees and dense shrubs.

Areas that are heavily infested with tall goldenrod (solidago altissima) will not be used by grassland birds. This aggressive native can be mowed annually, to weaken the plant.

Expected Changes

Habitat changes	Expected response of species groups	Net changes to species richness	Net change in abundance/diversity of species of conservation concern
Removal of woody vegetation	Grassland birds will nest in all areas with grassy cover in the next breeding season and as more grass is established their numbers and distribution will increase. New species such as Henslow's sparrow, bobolink and grasshopper sparrow will be attracted by the larger, unfragmented habitat.	Two or three new species will be added	Increase in abundance, distribution and diversity
Mowing tall goldenrod	If the mowing can sufficiently control		Increase in abundance and

	tall goldenrod, grassland birds will use the area to nest.		distribution

Response variables: number and species of birds, number and species of birds of conservation concern, habitat used by birds, presence or absence of bird species
Habitat Use Covariates: habitat type, date, bird species, mowing regime
Detection Covariates: observer, weather factors (storms), time of day

Step 5: Develop a statistically robust approach to sampling and data analysis

Monitoring objectives

Objective 1. Assess the population status of breeding and wintering species of concern: inventory all species using the site in summer and winter. Protocol: accumulation of checklists and other data, including all existing eBird and other birder and biologist data deemed to be reliable. If this is a site without much existing bird data, the point count protocol described below, with the addition of a few winter visits, can be used to develop an inventory. A species accumulation curve will determine when sufficient data has been gathered.

Objective 2. Monitor trends over time of breeding grassland species of concern.
Protocol: point count surveys with distance sampling and time removal

Objective 3. Monitor effects of conservation decisions on populations of grassland birds that use the prairie areas; specifically:
- timing of tall goldenrod mowing or
-Woody species control

In this hypothetical site, we have chosen to use the standardized protocol that was developed by the US Fish and Wildlife Service in 2008, the Landbird Monitoring Protocol. Protocol described is **point counts with distance sampling and time removal.** This protocol provides for trends analysis and effectiveness monitoring (which can be used for adaptive management) and is appropriate for one observer who is expert at recognizing birds by ear and estimating distances to birds upon hearing their songs and calls. We will analyze changes in abundance, density, occupancy and species richness of breeding landbirds. The accuracy of our analysis will be improved by estimation of detection probabilities.

At this site, we will implement a stratified random sampling design which will include replicates with and without the management action. Much of the guidance about choosing a sample frame and random points in the Landbird Monitoring Protocol is more appropriate for very large sites. At a 250-acre site (essentially 1 square kilometer), the entire site can be sampled in a morning by using 250m diameter point circles. This is a modification of the 300m recommended in the protocol. If 300m diameter were used on this site, only 4 points would fit; by reducing the diameter to 250m we are able to fit 9 points. The larger diameter is chosen to avoid double-counting, which has a serious effect on the analysis. However, grassland studies often use 200m diameter. Extra care should be taken to avoid counting the same bird twice.

At our hypothetical site, we have a treatment area of points 6-9 and an area that is not treated consisting of points 1-5. The treatment area could be either of the two possibilities we mentioned, invasive brush removal or tall goldenrod control.

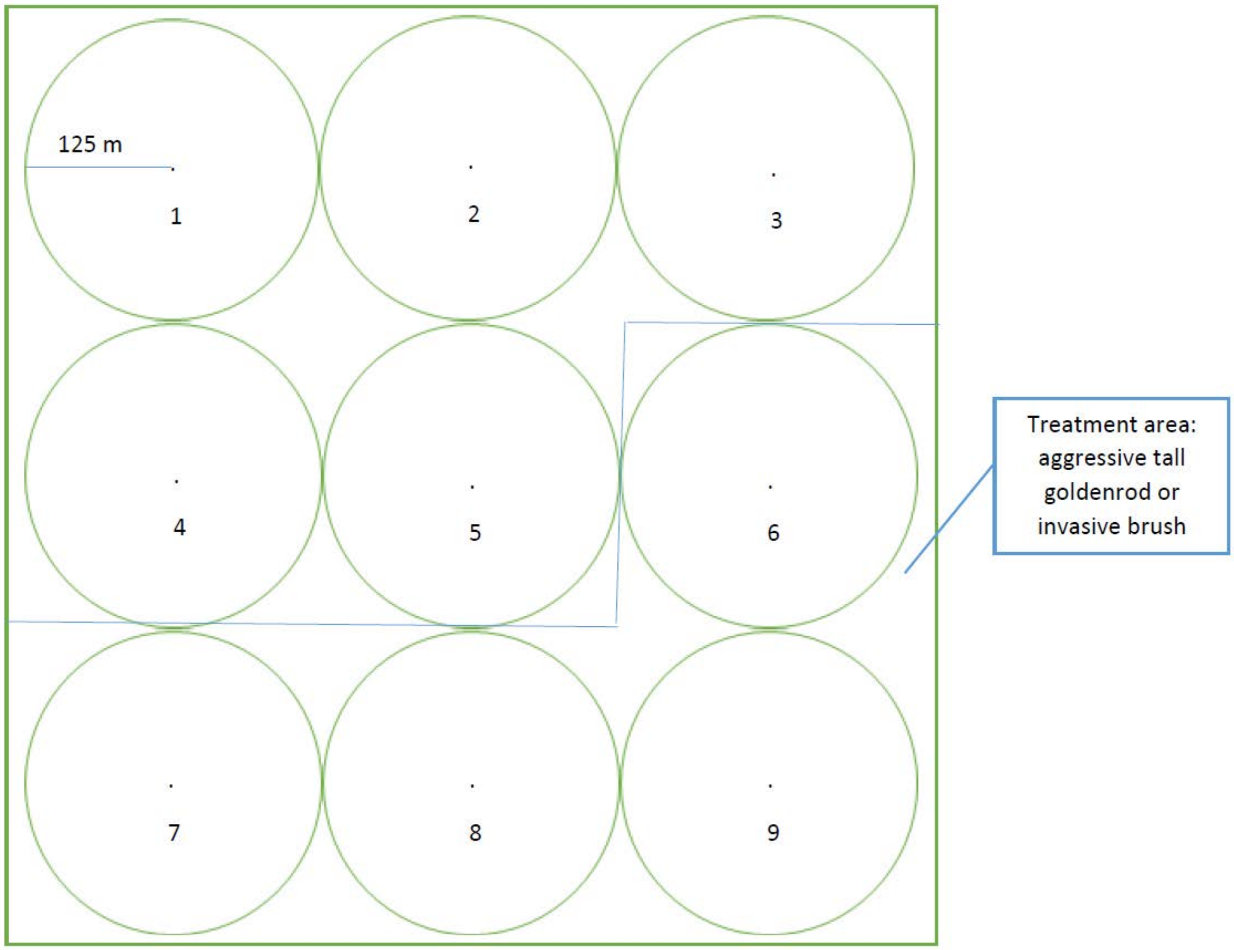


Figure 6. Treatment and reference point count circles

Step 6: Design and pilot standardized field protocols that minimize error and bias

The protocol calls for 10-minute point counts in which the minute that the bird is first observed is recorded and the bird is assigned to a distance band. Observers must be proficient in estimating distances and in recognizing birds by sight and sound. Training resources for bird songs and calls are described in Appendix B.

Screen and train observers
Simplify survey methods to focus attention on priority species and tasks.
Stratify to minimize site effects
Use standardized methods to control or model survey effects
Account for variation in detection rates, if called for by monitoring objectives
Obtain peer review of protocols
Test protocol and solicit feedback from observers
Use pilot data to establish quantifiable objectives and determine sample size

Points should be marked in the field with some sort of permanent marker. A t-bar or metal fence post can be used in a large grassland to help with navigation. Record a description of the permanent marker location using bearings and distances from natural features.

Before your field day assemble the following items:
binoculars
watch or timer which indicates seconds (consider one which attached to your clipboard)
waterproof boots
sufficient blank data forms, clipboard, rubber bands (for holding forms on clipboard)
writing implements
range finder
point location information

You may also need:
directions and maps, GPS unit & extra batteries, cell phone with GPS app such as MotionX-GPS (which will lead you to a point) and/or Perfect Mark (which takes very accurate readings), field guide, water and snacks, hat, sunscreen, insect spray

For more detailed suggestions see Standard Operation Procedure (SOP) #2: Before the Field Season (Knutson, 2008). This protocol is peer-reviewed.

Analysis of data from a pilot field visit will highlight any existing issues with your data frame and allow for correction before the field season begins.

Step 7: Identify or develop a data management system

In the bird monitoring community, there is an energetic focus on including as much data as possible into national databases where it will be available to other researchers. The Avian Knowledge Network (AKN) is a unified national effort, housed in Cornell Lab of Ornithology, to collect and make available avian datasets. The AKN has several regional nodes: ours is the Midwest Avian Data Center. Both provide data storage and analysis and visualization tools. EBird data is incorporated in to the AKN, so all data collected by the BCN via eBird is part of MWADC and AKN. MWADC is adaptable and can accept data from small studies.

Data gathered using the Landbird Monitoring Protocol can be entered into the Midwest Avian Data Center http://data.prbo.org/partners/mwadc/. MWADC archives the data and provides analysis tools to determine species richness, density and abundance, adjusted for detection probability. It allows for two different groupings of data in order to study the effects of treatment.

Step 8: Implement the monitoring program

Prepare for the field season
Perform survey
Enter and error-check data
Limited analysis to refine hypotheses

There are detailed instructions and a data form in Standard Operation Procedure (SOP) #5: Conducting the Point Count (Knutson, 2008)

Step 9: Present results in a format that supports sound management and conservation decisions

Interpret results and prepare reports with your audience in mind
Use knowledge of the surrounding landscape, ecology of the species, and an understanding of the details of the monitoring protocol to provide insight into what drives observed changes. Define the limits to which monitoring data should be applied. Consider your audience and how members of that audience will use the information.
Provide tools that inform management and conservation decisions – Useful tools can include management guidelines, paper maps, GIS data layers, or computer programs that simulate effects of management alternatives.

Step 10: Evaluate and adjust management and monitoring to make better bird conservation decisions

Evaluate the conceptual model
Adjust management if necessary
(include trigger point that would result in management modifications)

Trigger point: a decline in abundance of species of concern or species richness of 30% with 80% certainty over 10-year averages of BCN monitoring data.

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Appendix A: Birds of Conservation Concern in the Chicago Wilderness Area

Developed by the Bird Conservation Network, 2013, by stepping down national conservation rankings.

Level 1 Immediate Management Needed: Species having high regional threats and experiencing large population declines. Conservation action needed to reverse or stabilize long-term declines.
Level 2 Species experiencing moderate to strong declines and/or threats to breeding. Management or other actions needed to stabilize/ increase populations or reverse threats.
Level 3 Declines or threats to regional populations. Require management and monitoring. Includes certain widespread species plus species using only limited/localized habitats.
IL-E, etc. State endangered or threatened status

For a full description of the selection process, visit
http://bcnbirds.org/trends13/BCNBirdsofConcernProcess.pdf

Species Name	CONSERVATION STATUS	Habitat
Swainson's Hawk	IL-E	grassland
Northern Harrier	IL-E, IN-E	grassland
Short-eared Owl	IL-E, IN-E	grassland
Barn Owl	IL-E, IN-E	grassland
Grasshopper Sparrow	Level 1	grassland
Henslow's Sparrow	Level 1	grassland
Bobolink	Level 1	grassland
American Kestrel	Level 2	grassland
Upland Sandpiper	Level 2	grassland
Common Nighthawk	Level 2	grassland
Sedge Wren	Level 2	grassland
Dickcissel	Level 2	grassland
Eastern Meadowlark	Level 2	grassland
Western Meadowlark	Level 3	grassland
Northern Bobwhite	Level 1	shrubland
Black-billed Cuckoo	Level 1	shrubland
Loggerhead Shrike	Level 1	shrubland
Willow Flycatcher	Level 2	shrubland
Eastern Kingbird	Level 2	shrubland
Brown Thrasher	Level 2	shrubland
Bell's Vireo	Level 2	shrubland
Blue-winged Warbler	Level 2	shrubland
Yellow-breasted Chat	Level 2	shrubland
Field Sparrow	Level 2	shrubland
Peregrine Falcon	IL-T, WI-E	urban
Chimney Swift	Level 2	urban
Little Blue Heron	IL-E	wetland
Osprey	IL-E, IN-E	wetland

Yellow-crowned Night-Heron	IL-E, IN-E, WI-T	wetland
American Bittern	Level 1	wetland
King Rail	Level 1	wetland
Piping Plover	Level 1	wetland
Common Tern	Level 1	wetland
Pied-billed Grebe	Level 2	wetland
Least Bittern	Level 2	wetland
Black-crowned Night-Heron	Level 2	wetland
Common Gallinule	Level 2	wetland
Wilson's Snipe	Level 2	wetland
Wilson's Phalarope	Level 2	wetland
Yellow-headed Blackbird	Level 2	wetland
Black Rail	Level 2	wetland
Black Tern	Level 2	wetland
Forster's Tern	Level 2	wetland
Virginia Rail	Level 3	wetland
Sora	Level 3	wetland
Marsh Wren	Level 3	wetland
Caspian Tern	WI-E	wetland
Great Egret	WI-T	wetland
Red-headed Woodpecker	Level 1	woodland
Eastern Whip-poor-will	Level 1	woodland
American Woodcock	Level 2	woodland
Yellow-billed Cuckoo	Level 2	woodland
Northern Flicker	Level 2	woodland
Cerulean Warbler	Level 2	woodland
Acadian Flycatcher	Level 3	woodland
Wood Thrush	Level 3	woodland
Veery	Level 3	woodland
Louisiana Waterthrush	Level 3	woodland
Prothonotary Warbler	Level 3	woodland
Red-shouldered Hawk	WI-T	woodland
Hooded Warbler	WI-T	woodland

List of migrants of conservation concern

Common Loon	American Golden-Plover	Chimney Swift
Lesser Scaup	Solitary Sandpiper	Olive-sided Flycatcher
Greater Scaup	Greater Yellowlegs	Philadelphia Vireo
Common Goldeneye	Buff-breasted Sandpiper	Veery
Long-tailed Duck	Short-billed Dowitcher	Smith's Longspur
Horned Grebe	Bonaparte's Gull	Nashville Warbler
Rough-legged Hawk	Long-eared Owl	Cape May Warbler
Northern Harrier	Short-eared Owl	Chestnut-sided Warbler
Yellow Rail	Common Nighthawk	Golden-winged Warbler

Canada Warbler
Black-throated Green Wrb.
Mourning Warbler
Blackburnian Warbler
Bay-breasted Warbler
Black-and-white warbler
Connecticut Warbler
Le Conte's Sparrow
Nelson's Sparrow
Rusty Blackbird
Purple Finch

Appendix B: Bird Song Training Resources

The **Birder Certification Online** program provides a rigorous method for verifying field identification skills of both professional and non-professional bird observers. A major goal is to help validate the integrity of bird inventory and monitoring projects by improving and documenting birder identification skills. http://www.birdercertification.org/ This comprehensive site has different level quizzes and links to online practice quizzes, and it covers the birds of our region and not too many others.

These CDs have mnemonics which make it easy to learn the songs –

Bird Song Ear Training Guide: Who Cooks for Poor Sam Peabody? John Feith Audio CD Caculo label 2006.

Birding by Ear, Eastern/Central Richard K. Walton and Robert W. Lawson, Houghton Mifflin Company, 1989.

More Birding by Ear, Eastern/Central Richard K. Walton and Robert W. Lawson, Houghton Mifflin Company, 1994.

An excellent quiz app to practice bird song is made by Larkwire.

Field guide apps all have bird identification information including audio of songs for checking identification in the field. A code of ethics governs playing songs to attract birds. Sibley, iBird, Audubon Pro, National Geographic and Peterson all make them.

Getting out with other birders to practice on field trips is useful as well – The Illinois Birding Calendar lists field trips around the state, and you can select only our region: www.illinoisbirds.org/illinois-birding-calendar

Appendix C: Area Survey and Inventory data form

AREA SEARCH FORM – Eugene Field Park

Number of Observers: ______ **Start Time:** _______________ **End Time:** _______________

Weather interfered with detection of birds: yes ___ no ___

Observer Information		Census Information	
First Name	Last Name	Site	Date
Contact info			

Circle one: **Paired point study(areas 1-3) Inventory(Areas 4-7)**

Species	Area 1 (for paired point study only)	Area 2 (for paired point study only)	Area 3 (for paired point study only)	Area 4 (for inventory only)	Area 5 (for inventory only)	Area 6 (for inventory only)	Area 7 (for inventory only)

Notes and flyovers:

____

____

____

Other observers: ______________________________________

Appendix D: Avian Monitoring Methods

From Nur et. Al., 1999

Table 1. Monitoring methods used in landbird population monitoring and their characteristics.
Methods are grouped under "survey" and "demographic." Positive or high level is denoted by "+", negative or low level denoted by "–" and partial level denoted by "+/–". Modified from Table 1 in Butcher (1992). "Color banding" is assumed to include nest-searching. "Rare" species refers to species that are locally (not just globally) rare.

	Survey				Demographic		
Variables Measured	Fixed distance	Spot map	Area Search	Variable distance	Mist net	Nest Search	Color banding
Index to abundance	+	+	+	+	+/–	+/–	+
Density	–	+	–	+	–	–	+
Survivorship (adult)	–	–	–	–	+	–	++
Productivity	–	–	–	–	+	+	+
Recruitment	–	–	–	–	+	–	+
Habitat Relations	+	+	+	+	+/–	+	+/–
Nest Site Characteristics	–	–	–	–	–	+	+
Predation/Parasitism	–	–	–	–	–	+	+
Individuals Identified	–	–	–	–	+	–	+
Breeding Status Known	–	+	–	–	+/–	+	+
General Characteristics							
Habitat specificity	+	+	+	+	+/–	+	+
Rare species measured	+	+/–	+	+/–	–	+/–	+/–
Canopy species measured	+	+	+	+	–	+/–	–
Area sampled known	+	+	+	+	+/–	+	+
Large area sampled	+	–	+	+	+/–	–	–
Use in non-breeding season	+	+/–	+	+	+	–	+

Table 2. Potential objectives of a monitoring program and typical number of years needed for a method to achieve results.
Actual number of years depends on study design and will vary depending on sample size (e.g., number of census stations, detection or capture rates, number of nests found). We assume that the priorities of the monitoring program reflect local or site-specific needs (adapted from Geupel & Warkentin 1995).

	Method					
Objective	Single Point Counts[a]	Repeat Pt. Counts[b]	Area Search[c]	Spot mapping	Mist netting[d]	Nest monitoring[d]
Inventory, species presence/absence	1	1	1	1	1	na
Inventory locally rare species	2-3	1-3	1-3	1-3	1-3	na
Determine species richness	2-3	1-3	1-3	1-3	na	na
Determine relative abundance	1-2	1-2	1-3	1-2	3-5	na
Determine species breeding status/seasonality	na	1-3	1-3	1-3	1-3	1-3
Determine population trend	6-10	5-9	10+	5-9	6-10	na
Determine productivity	na	na	na	na	1-3	1-2
Determine adult survivorship	na	na	na	3-5[e]	3-5	na
Determine life history traits	na	na	na	2-4	na	1-2
Habitat association or preference	1-2	1-2	1-2	1-3	na	1-2
Identify habitat features	4-6	3-5	3-5	2-4	na	1-2
Determine cause of pop. change	na	na	na	na	3+	3+

[a] Each point count censused one time in a season.
[b] Each point count censused 3 or more times in a season.
[c] Each plot censused 3 or more times in a season.
[d] Most authors/programs recommend this method in conjunction with population surveys.
[e] Possible if birds have been uniquely color-banded.
[na] Not applicable or not possible.