THE INSTITUTE FOR BIRD POPULATIONS

Avian Monitoring Protocol for Sierra Nevada Meadows

A tool for assessing the effects of meadow restoration on birds

Version 1.0

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Cover: Little Truckee River, Sierra County, CA (H. Loffland) and Yellow Warbler (G. Jameson)

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I. INTRODUCTION

This protocol provides methods for monitoring birds at meadow restoration sites in the Sierra Nevada. It was developed with funding from the National Fish and Wildlife Foundation's Sierra Nevada Meadows Initiative, in a process that included review of existing methodologies, collaborative discussion, and peer review. The protocol underwent a trial season of implementation at approximately 60 sites (summer 2010) prior to finalization.

Ideally, bird monitoring at meadows undergoing habitat restoration should be implemented in a framework that includes at least one year of pre-restoration data collection and one year of post-restoration data collection at restoration sites as well as thoughtfully selected reference sites. However, restoration managers or researchers may face constraints on the resources they can allocate to bird monitoring or may have other competing project goals. Although this protocol recommends multi-year monitoring and the inclusion of one or more reference sites, it can easily be adjusted to accommodate constraints or serve other goals - including simply assessing the bird community at a single point in time at a single meadow, irrespective of whether restoration activities are planned.

Montane meadows in the Sierra Nevada form ecological islands within the surrounding forest matrix (Ratliff 1985, Fites-Kaufman et al. 2007). Because of their naturally patchy distribution, montane meadows comprise only a small percentage of the Sierra Nevada landscape (Ratliff 1982, Kattelmann and Embury 1996), but their importance to Sierra Nevada birds and other wildlife is disproportionately large. They provide abundant water, food, and cover for birds and other wildlife, and are among the most important breeding and foraging habitats for birds in the Sierra Nevada (Grinnell and Miller 1944, Orr and Moffitt 1971, Gaines 1992, Graber 1996, Heath and Ballard 2003). However, at many Sierra meadows human activities have altered meadow hydrology, which in turn has changed the characteristics of meadow plant communities, and often diminished the value of meadow habitat for native bird populations (Klebenow and Oakleaf 1984, Allen-Diaz 1991, Kattelmann and Embury 1996, Cicero 1997, Siegel et al. 2008).

Perazzo Meadows, Sierra County, and Willow Flycatcher, a California endangered species that is particularly sensitive to meadow degradation. (H. Loffland)

The plant and animal communities that inhabit Sierra meadows are greatly influenced by the hydrologic regimes within those meadows. Meadow wetness and plant community composition are susceptible to change due to hydrologic disturbance (Ratliff 1982, 1985, Allen-Diaz 1991, Kattelmann and Embury 1996, Rood and Mahoney 1999, Weixelman et al. 1999, Dwire et al. 2006).

Gullies like this one in Indian Valley, Alpine County, often result from disturbance and can lead to desiccation of meadows. (H. Loffland)

Throughout the Sierra Nevada, meadow hydrology and vegetation have been altered over the last 150 years as a result of human disturbances, including livestock grazing, upstream or adjacent logging, mining, road and bridge construction, recreation, draining for development or agricultural purposes, and inundation by reservoir construction (Ratliff 1985, McKelvey and Johnston 1992, Kattelmann and Embury 1996, Poff et al. 1997, Barnett et al. 2008). Impacts to meadow streams from direct and indirect disturbance (erosion, scouring, compaction, loss of vegetative cover) have resulted in de-watering of many historically wet meadows. Due to these change in hydrology, meadow-associated herbaceous plant communities, as well as riparian shrub communities, have declined, while sagebrush and conifers have encroached into many meadows (Ratliff 1982, Kauffman and Krueger 1984, Stromberg 1993, Knapp and Matthews 1996, Belsky et al. 1999, Norman and Taylor 2005, Simon et al. 2006, Bilyue et al. 2008).

Many public and private land managers are now seeking solutions that benefit both humans and wildlife by restoring or enhancing meadow habitats, in many cases addressing the historical legacy of hydrological impacts that have led to poorly watered meadows (Rood and Mahoney 1990, Loheide and Gorelick 2006, Skidmore et al. 2009). Restoring meadow hydrology is often a critical first step in restoring the full complement of native biodiversity to a meadow (Poff et al. 1997, Dwire et al. 2006).

Well-functioning hydrologic processes in montane meadows not only yield improved habitat for wildlife, but may also provide tangible benefits for humans, including:

- increased water storage capacity (Loheide and Gorelick 2006, Skidmore et al. 2009),
- improved water quality (Alexander et al. 2007, Simon et al. 2006),
- downstream flood attenuation (Gurnell et al. 1995, Skidmore et al. 2009),

- increased duration of summer flows (Alexander et al. 2007), and
- improved forage quality for livestock (Ratliff 1985).

One way to evaluate the ecological success of meadow restoration projects is to monitor the responses of bird populations that inhabit the meadow. Birds can respond rapidly and dramatically to meadow restoration efforts, with populations of some meadow-associated bird species increasing in or even colonizing meadows within as little as one year after restoration efforts are implemented (Taylor and Littlefield 1986, Larison et al. 2001, Stanley and Knopf 2002, McCreedy and Heath 2004, Heltzel and Earnst 2006). Nonetheless, the majority of the available knowledge base related to bird response to restoration is based on response to passive restoration resulting from changes in land management, most often grazing. Assumptions regarding the benefits of active hydrologic and vegetative restoration to birds have only begun to be tested in recent years (Borgmann and Morrison 2008, Burnett and Fogg 2011, Gardali et al. 2011).

Here we provide a peer-reviewed, comprehensive protocol for conducting multi-species bird surveys at Sierra Nevada meadows. Conducting surveys both before and after restoration activities occur, and pairing them with parallel survey efforts at reference sites that are not slated for restoration, will enable land managers and researchers to document the effect of meadow restoration on bird populations.

Adopting a standardized survey protocol will yield consistent, comparable monitoring efforts across diverse projects and sites, and across multiple years. This consistency in methodology will allow managers and researchers to glean important lessons from restoration monitoring efforts—lessons that cannot be learned from monitoring at any single site. Standardized data from diverse sites that undergo a variety of restoration measures will facilitate comparison of bird responses across sites and projects. Such comparisons will lead to an improved understanding of which restoration efforts most effectively produce high-quality bird habitat, and will improve future meadow restoration efforts.

Additionally, implementing a standardized protocol that can document meadow restoration benefits to wildlife will yield quantitative measures of success – measures that are frequently needed by land managers to obtain funds and justify continued work on restoration projects.

II. WHY MONITOR BIRDS?

Despite their relatively sparse distribution and sensitivity to disturbance, montane meadows are among the most biologically productive communities in the Sierra Nevada and play a crucial role in the life-history and ecology of many Sierra bird species (Grinnell and Miller 1944, Orr and Moffitt 1971, Stewart 1977, Gregory et al. 1991, Gaines 1992, Cicero 1997, Lynn et al. 1998, Morton 1992, Bombay et al. 2003b, Cain and Morrison 2003, Heath and Ballard 2003, Borgmann 2010). The juxtaposition of water, herbaceous vegetation, and riparian shrubs create needed habitats for both aquatic and terrestrial life stages of many insect species on which meadow birds prey (Erman 1984, Gray 1993, Erman 1996, Hatfield and LeBuhn 2007). In addition, Sierra meadows provide dense

herbaceous cover for avian nesting, predator avoidance, and thermal cover, and bountiful seed crops for granivorous birds in late summer and fall.

MacGillivray's Warblers often nest in dense shrubs at meadow edges.

Each bird species that utilizes montane meadows in the Sierra Nevada has its own particular habitat needs, and the presence or absence of those specific habitat components largely predicts which species utilize a particular meadow (Wiens 1985, Green 19995, Cicero 1997, Wilkerson and Siegel 2002, Bombay et al. 2003b, Heath and Ballard 2003). When meadow habitats are degraded, the number of individual birds and the number of bird species occupying them tends to decline. Even when species persist at degraded sites, the changes to habitat components may reduce reproductive success or survival through changes in predator abundance or access, insect prey, nesting substrates and thermal cover (Van Horne 1983, Cain et al 2003, 2005, Mathewson 2011, Larison et al. 2001). Additionally, because some species use social cues to make decisions about habitat quality, declining bird numbers may affect site fidelity and colonization patterns (Ward et al. 2010, Ward and Schlossberg 2004, Mathewson 2010). Non-degraded meadows thus provide important and sometimes essential habitat for many Sierra Nevada bird species. Populations of many bird species can be monitored relatively easily with a single survey protocol, making birds an ideal indicator of the effects that meadow restoration efforts have on wildlife.

This protocol is designed to assess bird populations at Sierra Nevada meadows during the breeding season - generally between mid-May and mid-July, depending on elevation.

Many Sierra Nevada bird species breed almost exclusively in meadow and meadow-riparian areas, utilizing the dense cover from grasses, sedges, and forbs, or riparian deciduous shrubs for nesting. Examples include Sandhill Crane, Wilson's Snipe, Spotted Sandpiper, Willow Flycatcher, Yellow Warbler, MacGillivray's Warbler, White-crowned Sparrow, Lincoln's Sparrow, and Song Sparrow. Many species that are tree- or cavity-nesters and generally build their nests outside of meadows nevertheless forage largely or entirely within meadows or riparian zones, including Great Gray Owl, Red-breasted Sapsucker, and Warbling Vireo. Some species that would otherwise be found in fresh water marshes frequently breed in the flooded portions of wet meadows, including Green-winged Teal, Virginia Rail, Sora, Wilson's Phalarope, Common Yellowthroat, and Red-winged Blackbird. Another group of bird species that make use of meadows are edge species or habitat generalists. While they also occur

in other non-meadow habitats, these species are frequently most abundant along the meadow/forest ecotone. Such species include Mountain Bluebird, American Robin, Black-headed Grosbeak, Spotted Towhee, Chipping Sparrow, Dark-eyed Junco, Fox Sparrow, and Brewer's Blackbird.

Sierra meadows are also important to migrating and dispersing birds during the post-breeding period (Morton 1991, Morton et al. 1991, Kelly et al. 2002, Wilkerson and Siegel 2002). These birds take advantage of the abundant late-summer food reserves found in meadows, as well as the cover provided by lush meadow vegetation. Species using meadows during the post-breeding period include up-slope dispersers, various montane forest/chaparral breeders, and southbound long-distance migrants.

Dark-eyed Junco nest at a meadow edge. (J. Wu)

Upslope-dispersing species include species such as House Wren, Orange-crowned Warbler, and Nashville Warbler that typically nest at low to middle elevations in the Sierra in forested or brushy settings. After breeding, adults and young travel upslope to higher-elevation meadows where they spend the remainder of the summer gaining weight and molting prior to fall migration. Similarly, many forest-nesting birds including Yellow-rumped Warbler, Hermit Warbler, Dark-eyed Junco, and Pine Siskin leave their forest territories to take advantage of the insect resources in meadows during mid- and late-summer. Finally, a few species of birds that breed farther north in the US and Canada use Sierra meadows heavily as stopover locations during southward migration. The most notable of these is the Rufous Hummingbird, which is found in high densities in Sierra meadows during late summer, despite the fact that it does not breed in the region. Another example is Willow Flycatcher – a species that is quite rare or absent from most of the Sierra – but is often captured in mist nests during migration at meadows where it does not breed.

Bird species that nest and forage in or around Sierra meadows include several state or federally protected species: Great Gray Owl, Willow Flycatcher, Black Rail (low-elevation sites only) and Greater Sandhill Crane (Table 1). Similarly, many meadow-associated birds (Table 1) are classified by the state of California as "bird species of special concern" (Shuford and Gardali 2008). Some of these special-status species are uncommon in the montane zone of the Sierra Nevada or rely more heavily non-meadow habitats. However, all are known to at least sometimes breed or forage in meadows or riparian areas of the Sierra Nevada. In addition, numerous other bird species not designated as species of management concern nevertheless depend on meadow habitat to varying degrees during the breeding season, and populations of some of them are declining.

Table 1. Special-status, meadow-associated bird species in the Sierra Nevada.

Species Name	California Status[2]	Federal Status[2]
Greater Sandhill Crane	ST, FP	
Black Rail	ST, FP	
Great Gray Owl	SE	S
Willow Flycatcher	SE	S
Southwestern Willow Flycatcher	SE	FE
Northern Harrier	CBSSC	
Yellow Rail	CBSSC	
Long-eared Owl	CBSSC	
Short-eared Owl	CBSSC	
Yellow Warbler	CBSSC	
Yellow-breasted Chat	CBSSC	
Yellow-headed Blackbird	CBSSC	

[2]ST=state threatened; SE=state endangered; FP= fully protected; S=Forest Service sensitive; FE=federally endangered; CBSSC=California bird species of special concern

Although this protocol is intended only for use during the breeding season for most Sierra species, well-functioning meadow systems also aid many additional species of birds that utilize meadows outside of the breeding season.

III. PROTOCOL OBJECTIVES

This monitoring protocol was developed for assessing changes in bird populations resulting from meadow restoration projects. Specifically, we designed the protocol to:

- Detect change in the abundance of meadow-associated bird species as it relates to the effects of restoration activities.
- Detect community-level changes, including changes in species richness, at meadows as those changes relate to the effects of restoration activities.
- Yield information that will allow managers to continue to test and hone the efficacy of meadow restoration techniques for improving bird habitat.

The capacity of this monitoring protocol to detect changes in bird populations over time (particularly before and after meadow restoration efforts are implemented) will vary based on factors such as the species being assessed, the number of monitoring points per meadow, and the number of meadows examined. Recent work in central and northern Sierra meadows (Amones 2008) suggests that pooling data from multiple restoration projects in Sierra meadows and analyzing them at the regional or sub-regional scale is likely to be a particularly fruitful means of assessing the efficacy of restoration activities. However, even managers interested in only a single restoration site will find this protocol useful for inventorying the avifauna at the site, and then assessing restoration-related changes to bird populations.

Occupancy patterns and abundance of meadow bird species are affected by multiple habitat components, some of which take time to develop in a post-restoration setting (mature willow or aspen stands, for example). Meadow restoration is unlikely to result in immediate change to all components of the meadow ecosystem and therefore it is

unlikely that there will be an immediate response from all bird species. The amount of time since restoration that is required to result in changes in abundance, and especially re-colonization, is likely to vary by site depending factors including:

- pre-restoration bird abundance and habitat condition
- proximity to seed sources for important meadow plant species,
- proximity to, and abundance of, off-site source populations of meadow bird species, and
- the efficacy of restoration efforts and the degree of change that they produce.

This monitoring protocol is intended as a base level of monitoring appropriate for all meadow restoration projects and for answering questions related to population-level responses to restoration. More intensive monitoring techniques and research methods may be appropriate for answering additional questions related to species-specific demographic responses to meadow restoration.

IV. SAMPLING DESIGN

Sampling design for this protocol is a BACI (Before, After, Control, Impact) framework; we recommend that all monitoring sites where restoration activities are planned be paired with an additional reference site with similar hydrology and vegetation, but where no restoration activities are planned. All monitoring activities can then be carried out at both the restoration and reference sites in at least one year prior to restoration and one year after restoration. This design improves the manager's ability to separate local population changes that are the result of restoration from regional changes that may be due to annual weather variation or other factors. Comparing change in bird populations at the restoration site (Impact) with the reference site (Control) will allow managers to see how individual bird species and suites of species respond to restoration activities, and how the response varies by type of restoration activity, locality, and, if multiple years of post-restoration monitoring are conducted, time since restoration activity (Smucker et al. 2005, Ward et al. 2010).

V. SITE SELECTION

The sampling described in this protocol was designed to be initiated at meadows prior to restoration. This does not necessarily preclude sites where restoration activities have occurred in the past, but, preferably, these past activities will have occurred not so recently that the ecosystem is still in flux as a direct result. Sites where restoration activities are not planned for a few years are ideal because this timeframe allows for more than one year of pre-restoration data collection. Multiple years of pre-restoration bird monitoring will help to identify and account for normal annual fluctuations in bird populations and communities at the site during the assessed time period.

If a restoration project area is limited to a portion of a much larger meadow, it may be appropriate to collect bird data from only the part of the meadow likely to be affected. However, bird populations outside the direct restoration project area may also be affected by restoration activities, if food or predator resources respond to the restoration and travel into other parts of the meadow (Gardali et al 2011).

When resources permit, we recommend selecting and surveying a paired reference site whenever a restoration site is surveyed. Pairing sites in this manner will help untangle the effects of restoration activities from annual changes in bird populations that may be unrelated to local restoration efforts. This is particularly important for migratory bird species, for which population changes may be due to habitat conditions on the wintering grounds or migratory routes, rather than on the breeding grounds. **Nevertheless, surveying reference sites is not strictly necessary, and the inability to do so should not dissuade restoration practitioners from monitoring birds at restoration sites.**

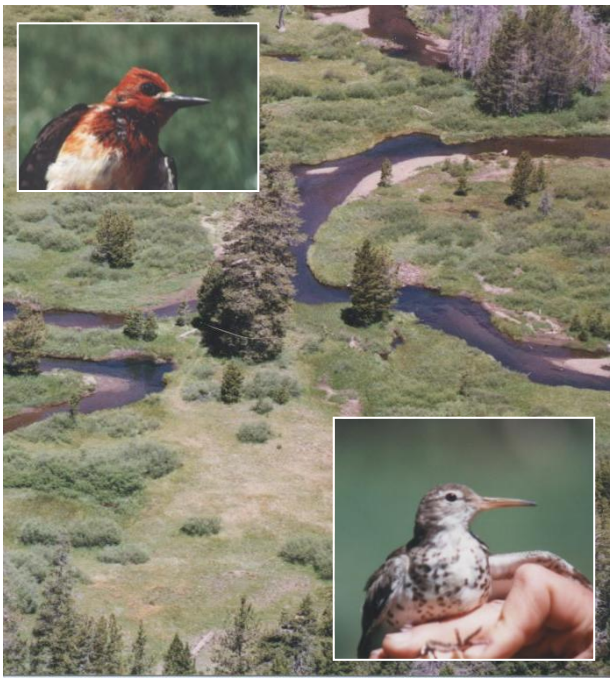
When selecting reference sites there are a number of criteria to consider:

- proximity to the restoration site
- similar elevation and position relative to the Sierra Nevada crest
- similarity of vegetation (prior to restoration)
- similarity of hydrology (prior to restoration)
- past management history
- plans for future restoration

Ideally, reference sites should be located close enough to the restoration site to be affected by the same general weather fluctuations and to recruit from the same general source populations of birds. However, restoration and reference sites should not be so close that restoration activities alter the bird community at the reference site due to local movements in response to habitat change (Smucker et al. 2005). This potential lack of biological independence is one reason it is not ideal to use the untreated portion of a meadow as the references site for the treated portion of a meadow.

Similarity of pre-restoration vegetation is one of the most important criteria for selecting reference sites. For most bird species, the vegetation community drives presence or absence, and abundance. Ideally, the reference and restoration sites will harbor similar pre-restoration bird communities, and vegetation is the best clue for determining general bird community prior to actual surveys. For example, if the restoration site has a riparian shrub component, effort should be taken to select a reference site with similar riparian shrub cover, even if the species of shrubs are not identical. The same can be said for selecting reference sites that are considered “wet”, “moist”, or “dry” meadow communities, or sagebrush-dominated communities. In many cases, a perfect match is not available in close proximity; in these cases, matching vegetation structure may be more useful than ensuring close physical proximity. However, longitude and elevation restrict some avian species distributions, so sites matched with respect to these factors will yield more meaningful results.

When multiple possible reference sites with similar vegetation are available, selecting a reference site with similar hydrology is preferable. This ensures that species associated with water will have a similar likelihood of occurring at each site within the pair. An example is to pair a meadow within a large riverine flood plain with another similar site, rather than with a site that is fed by a small spring and has no discernable flow regime.



Red-breasted Sapsucker and Spotted Sandpiper at Caples Creek, Amador County. (H. Loffland)

Optimally, reference sites should not be slated for restoration activities within the foreseeable future, or, at least, not within several years after the completion of the current restoration site activities. Similarly, having a restoration and reference site with similar past and current management activities (grazing, mining, recreation, etc.) and similar levels of pre-restoration disturbance will result in easier assessment of outcomes. When future management plans for a reference site are uncertain, and also because unforeseen natural events sometimes occur, it may be useful to identify an additional alternate reference site where monitoring will also occur. This is especially appropriate if the primary reference site is small and accommodates fewer than 6 survey stations.

VI. OVERVIEW OF MONITORING TECHNIQUES

We recommend a suite of bird monitoring techniques be implemented twice per season in at least one year prior to restoration and one year after restoration is implemented (but not necessarily the first year after restoration). Depending on sample sizes, these techniques can yield species-specific information including presence, relative density, absolute density, detection probability, occupancy probability, and within-meadow habitat associations. They can also yield community-level information including species richness. However, if personnel or resources are limiting, conducting a single survey per year (rather than two) is acceptable.

Recommended survey techniques include point counts, broadcast surveys, area searches, and vegetation assessments. An overview of each technique is provided below, with detailed methods described in the appendices.

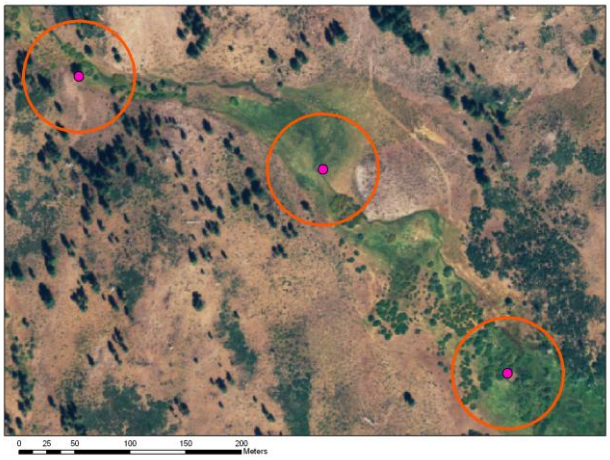
a. Point counts – required

Summary features

- 7 minutes at each station
- 3 time intervals
- estimate initial distance to each bird (or simply note whether ≤50 m or >50 m
- 250 m spacing between stations
- completed within 4 hours after local sunrise
- 2 visits between May 20 - July 15

Survey stations (used for point counts, broadcast surveys, and vegetation assessment) should be spaced 250 m

apart to maximize the number of stations per meadow, while minimizing the frequency with which individual birds are detected from multiple survey stations during point counts. Conducting two visits per season will increase the likelihood of detecting rare or secretive species and will bolster the power of occupancy modeling efforts, but the second visit is nevertheless not strictly necessary.



Upper Bear Valley, Sierra County, with survey stations (small red dots) and 50-m point count radii (orange circles).

Survey stations should be sited along transects that follow the general course of stream channels within the meadow, as well as in areas of the meadow with no adjacent stream. If possible, survey stations should also be at least 25 m from streams that are large enough to cause substantial noise interference during surveys – this will also help ensure that if stream restoration results in inundation or alteration of the channel, survey stations do not end up under water. Inundation could prevent or hinder repeat monitoring activities at survey stations in subsequent post-restoration years. Whenever possible, coordinating the locations of multiple aspects of meadow monitoring including bird survey stations, ground water monitoring wells, meadow cross sections, etc. may provide additional strength to post-restoration analyses and inferences. **Detailed instructions for establishing survey stations are provided in *Appendix A: Establishing survey stations.***

Bird monitoring activities should only be conducted when ambient noise, wind, fog, or rain are not impairing the surveyor's ability to identify birds by sight and sound or substantially reducing bird activity. Additionally, adverse weather conditions can alter bird behavior and reduce detection probability, thereby biasing monitoring results. **Detailed instructions for recording site conditions (including weather) are provided in *Appendix B: Assessing site conditions and recording site summary information*.**

Point count duration, number of survey stations, number of surveys, and use of song broadcast techniques can all affect the results of bird monitoring using point counts (Buskirk and McDonald 1995, Lynch 1995). Amones (2008) and Borgmann (2010) examined optimal sampling intensity in Sierra meadow systems by conducting repeated visits over the entire breeding season and then assessing how variation in the numbers of stations, points, and point count duration affected ability to detect trends and describe bird community richness and diversity. Based on their work and other recent or ongoing monitoring efforts in the Sierra Nevada (Borgmann and Morrison 2008, Wilkerson and Siegel 2002, Siegel et al. 2010, Burnett and Fogg 2011, Roberts et al. 2011) we designed a point count methodology that maximizes detection probability and provides compatibility with most other monitoring

efforts, while still recognizing the cost and time limitations of most land managers (Lynch et al. 1995, Ralph et al. 1995).

We selected a 7-minute point count partitioned into 3 smaller time intervals to allow for estimation of detection probability. Detection probability must be estimated when the goal is to estimate occupancy rates or absolute abundance of birds – rather than relative abundance (e.g., birds detected per point count). Relative abundance may be adequate for the needs of some projects, but even if project personnel do not intend to estimate detection probability we urge the collection of these data so that they can be used by other researchers for regional analyses (Royle and Dorazio 2008, Saracco et al. 2011). Partitioning the data into birds detected during the first three minutes of the point count facilitates comparison with results from the continent-wide Breeding Bird Survey, which utilizes 3-minute point counts. Similarly, partitioning the date into two additional 2-minute time bins (minutes 4 and 5, and minutes 6 and 7) allows comparison with standard 5-minute and 7-minute counts used for other bird monitoring efforts in the region (e.g., Siegel et al. 2010, Roberts et al. 2011).

For practitioners wishing to estimate detection probability, this protocol yields data for two distinct methods: occupancy modeling (MacKenzie et al. 2002) and distance sampling (Buckland et al. 2001). Occupancy modeling is facilitated by dividing the point count into discrete time intervals, each of which can later be treated analytically as a 'capture opportunity' in a mark-recapture framework. Distance sampling provides an alternative analytical framework for estimating detection probability, based on estimated distances to each bird detected during point counts. Observers who are not skilled in distance estimation may opt to use fixed-radius sampling in which individual birds are recorded as within or outside a 50-m radius at the time of first detection. Note, however, that classifying birds as within or outside a 50-m radius still requires substantial practice, and can bias results if not done accurately. **Detailed instructions for conducting point counts are provided in *Appendix C: Conducting point counts.***

b. Broadcast survey – optional

Summary features

- targets secretive or rare species
- conducted immediately after point count at each station
- completed within 4 hours after local sunrise
- 2 visits between May 20 - July 15

Broadcast surveys can dramatically increase detection probability, and are most appropriate for rare or secretive species, or for situations where managers place a great premium on having as complete as possible a census of a particular species.

The most efficient way to incorporate broadcast surveys is to conduct them immediately following each 7-min point count. The observer should remain at the survey station and broadcast vocalizations of the target species. Vocalizations should only be broadcast if the target species was not already detected within 50 m of the survey station during the preceding 7-minute point count. **Detailed instructions for conducting broadcast surveys are provided in *Appendix D: Conducting broadcast surveys.***

c. Area search – optional

Summary features

- entire meadow is searched
- a minimum of 10 minutes per survey station, no maximum time constraint
- completed within 4 hours after local sunrise
- 2 visits between May 20 - July 15

Area searching (Slater 1994) is an avian survey method that simply requires observers to move through a pre-defined area slowly and quietly, counting all birds detected. Although area search data are less amenable to statistical testing than point count results, one substantial advantage is that they can potentially yield a more complete count of individuals of focal species that might have been selected to assess effects of restoration at a site. Selecting focal species is not a necessary component of this survey protocol, but can be a way for project managers to focus attention on a few species that are most likely to benefit from restoration efforts.

Recommended focal species – birds that are strongly associated with meadow habitats and whose local populations are likely to respond to restoration - are listed in Table 2. The species in Table 2 are likely to serve well as focal species for most Sierra meadow sites in the montane zone, but sites in the subalpine zone or foothills may require different focal species. These species also utilize a variety of habitat components within meadows such as, riparian shrubs, emergent vegetation, etc., and therefore represent a cross-section of the complete meadow-associated bird community.

Table 2. Recommended focal bird species for assessing meadow restoration efforts, and their usual nesting habitat within meadows.

Focal Species	Usual Nesting Habitat within Meadows
Sandhill Crane	*M, E*
Virginia Rail	*E*
Sora	*E*
Spotted Sandpiper	*G*
Wilson's Snipe	*E*
Red-breasted Sapsucker	*S, A*
Willow Flycatcher	*S, E*
Swainson's Thrush	*S, A*
Warbling Vireo	*S, A*
Yellow Warbler	*S*
MacGillivray's Warbler	*S, A*
Common Yellowthroat	*S, E*
Wilson's Warbler	*S, A*
Yellow-breasted Chat	*S*
Song Sparrow	*M*
Lincoln's Sparrow	*M*
White-crowned Sparrow	*S, M*
Brown-headed Cowbird	*ALL*

A = Aspen; E = emergent vegetation and surface water; G = gravel bars and streamside zone; M = open meadow; S = riparian deciduous shrubs.

Area searches also provide the opportunity to actively search for rare or secretive species that might be missed during point counts, and that are of special management interest. Finally,

area searching lends itself to involving the public in monitoring activities. Because the area search methodology we are recommending is not tied to rigorous timing constraints, excellent acoustic birding skills, or distance estimation skills, observers only need to be competent at identifying the focal species in question. Because there is no upper limit on the amount of survey effort, the method can potentially accommodate as many volunteers as would like to participate. Incorporating volunteers into the monitoring strategy for a restoration site can add multiple benefits to a project, including public education and outreach, and can also create a low- or no-cost component to the overall monitoring strategy.

The amount of time spent area searching is flexible, but should be influenced by the size of the meadow and the number of survey stations. For every survey station the meadow accommodates, we recommend at least 10 observer-minutes be spent on area searching – so a small meadow that accommodates 6 survey stations should receive at least 60 person-minutes of area searching. Special attention should be paid to areas along stream channels or other flooded/ponded areas, and locations where restoration activities are planned or completed. Additionally, areas of the meadow where sight and sound are obstructed by dense vegetation should be searched carefully. Although more time may be spent in these specific portions of the meadow, all areas and vegetation communities should be searched. One of the objectives of the area search is to optimize the likelihood that all species present at the site have been detected, even if missed during the point count and broadcast portions of the survey. **Detailed instructions for conducting area searches are provided in *Appendix E: Conducting area searches.***

d. Vegetation assessment – optional

Summary features

- 50-m radius plots centered on each survey station
- 4 quadrants for ocular cover estimates of vegetation and water cover
- completed once between May 20 - July 15

Although this is a primarily an avian monitoring protocol, measuring basic habitat components that are generally important to meadow birds and that might be expected to change with meadow restoration activities can provide valuable insight into the causes of changes in bird populations. If more extensive vegetation monitoring is not occurring as part of the restoration effort (and perhaps even if it is occurring), we urge bird surveyors to devote the needed resources to collecting habitat data at survey stations.

After reviewing available methods designed for monitoring meadow and riparian communities (Weixelman et al 1999, Winwood 2000, Weixelman et al 2003, Coles-Ritchie et al. 2004, Purdy and Moyle 2006) we determined that while species-level plant identification would provide the most accurate measure of change in meadow plant communities, gross ocular estimates of targeted plant taxons and growth forms would meet our objective of describing general habitat characteristics important for meadow associated bird species. Our method of assessing meadow vegetation characteristics is not intended to replace

more in-depth monitoring of species-specific change in meadow vegetation.

Lodgepole pine encroachment at Gray Eagle Lodge, Plumas County. (H. Loffland)

The physical and biological measurements we recommend focus on characteristics that are of importance to nesting and foraging birds and that might be expected to change as a result of meadow restoration: total riparian shrub cover and recruitment of young/small age classes of riparian shrubs, extent of standing and moving water, sagebrush cover, conifer and aspen cover, conifer recruitment (encroachment), aspen recruitment, and the extent of bare ground. These variables are important within the life histories of many meadow-associated focal species and relatively straight-forward to measure for a person without extensive botanical training. Measurements of mature riparian shrubs and recruitment of young riparian shrubs are warranted by the habitat requirements of many meadow-associated species, particularly shrub-nesting species like Willow Flycatcher and Yellow Warbler, as well as species like MacGillivray's Warbler and Wilson's Warbler that frequently nest under riparian shrubs (Bombay et al 2003b). Sagebrush cover and conifer encroachment are associated with water table declines and indicate poor habitat quality for many meadow-associated species that rely on dense non-woody nesting cover and abundant insect resources. Aspen cover indicates potential habitat for species such as Red-breasted Sapsucker and Warbling Vireo. Cover measurements of large herbaceous forbs - corn lily *(Veratrum californicum)* for example - indicate preferred habitat for ground-nesters such as Lincoln's Sparrow, and the presence of emergent vegetation indicates potential foraging and nesting habitat for Wilson's Snipe, Greater Sandhill Crane, and a number of rail and waterfowl species. Extent of gravel bars provides an indicator of Spotted Sandpiper foraging habitat.

Vegetation and water cover are estimated for 50-m circular plots centered on each survey station. Each plot is divided into 4 quadrants created by 50-m transects extending in the 4 cardinal directions from the survey station. We choose to divide a 50-m circular plot into quadrants for ease of assessment. By utilizing pie-shaped wedges of a circular plot the surveyor can more easily see and estimate cover values while standing at the central survey station. Vegetation data are collected once between May 20 and July 15 in association with one of the two recommended bird monitoring visits. Linking the vegetation measurements to the same locations as the point counts yields greater ability to explain changes in bird populations, and to assess the characteristics of successful restoration projects.

In addition to the vegetation cover data described above, basic vegetation phenology for the site is recorded on the

Site Conditions and Site Summary Information form for each visit. These measurements record the condition of vegetation and snow-pack and have implications regarding the suitability of the site for foraging and particularly nesting at the time of the visit. **Detailed instructions for conducting vegetation and soil moisture measurements are provided in *Appendix G: Assessing vegetation and soil moisture,* and in *Appendix B: Assessing site conditions and recording summary information.***

e. Additional single-species surveys - optional

A number of single-species survey protocols exist that may be useful in combination with this multi-species survey protocol. Incorporation of these additional protocols could be spurred by legal requirements and/or management concerns about particular species. Single-species survey protocols will generally yield higher detection probability for target species than is obtained with this multi-species survey, and should be used in situations where a high level of certainty related to occupancy or abundance is desired, and resources exist for investing additional survey effort. In some cases, when legally protected species are known to currently or historically occupy a meadow planned for restoration, the National Environmental Policy Act (NEPA) or the California Environmental Quality Act (CEQA) may require single-species surveys prior to restoration activities. **The use of the following survey protocols requires special permitting (M.O.U.s, collection permits, and/or research permits) from the California Dept. of Fish and Game, United States Fish and Wildlife Service, or both (see Section VI: Permitting), as well as permission from the appropriate federal agency (e.g., National Park Service) is conducted on federal lands.**

Great Gray Owl

Although there have been a number of recent observations of Great Gray Owl breeding in foothill oak/pine savannah settings in California, the majority of the Great Gray Owl population in the Sierra Nevada utilizes meadows for foraging, and nest locations are almost all within 200 m of a meadow edge. The highly restricted range of the Sierra Nevada Great Gray Owl population and its apparent genetic differentiation from Great Gray Owls elsewhere (Hull et al. 2010) indicate an isolated and “at risk” population (Beck and Winter 2000). The most widely used protocol for surveying this species in the Sierra Nevada (Beck and Winter 2000) requires 6 visits during the late winter through summer period, although more recent research suggests fewer visits may be sufficient (J. Keane personal communication). Even if nocturnal surveys are not planned, we highly recommend using the methods described in the “daytime visit” portion of the Beck and Winter (2000) protocol to search for feathers and pellets along the margin of meadows, especially meadows within 50 km of Yosemite National Park, where most known territories in the Sierra Nevada occur. Feather and pellet searches could easily be added after area searches are complete. Note, however, that appropriately-sized pellets are generally not conclusive evidence of Great Gray Owl presence, as they can be indistinguishable from Great Horned Owl pellets. Use of a camera and available feather identification guides (see below) may also be helpful. Without targeted efforts, Great Gray Owls could easily be missed by diurnal, multi-species surveys.

Beck, T. W., and J. Winter. 2000. Survey protocol for Great Gray Owl in the Sierra Nevada of California. USDA Forest Service, Pacific Southwest Region, Vallejo, CA. http://www.dfg.ca.gov/wildlife/nongame/docs/ggo_sn_proto.pdf

The feather atlas: flight feathers of North American birds, USFWS website. http://www.lab.fws.gov/featheratlas/

Willow Flycatcher

In the Sierra Nevada, Willow Flycatchers are almost completely restricted to breeding in willow–dominated, wet montane meadows. Anecdotal and demographic studies indicate a dramatic decline in the Sierra Nevada Willow Flycatcher population since the 1920s when this species was considered locally common in riparian areas (Ray 1903, 1913, Orr and Moffitt 1971, Gaines 1992). These regional declines, as well as local extirpations from most southern Sierra locations, have been well documented since 1980 (Harris et al. 1987, Bombay et al. 2003b, Siegel et al. 2008, Mathewson 2010).

For areas within the range of the state endangered Willow Flycatcher subspecies *E.t. adastus* or *E.t. brewsterii*, the most widely used survey protocol (Bombay et al 2003a) requires two visits between June 1st and July 15th.

Bombay, H. L, T. M. Benson, B. E. Valentine, and R. A. Stefani. 2003. A Willow Flycatcher survey protocol for California. USDA Forest Service, Pacific Southwest Region, Vallejo, CA. http://dfg.ca.gov/wildlife/nongame/docs/wifl_2003_protocol.pdf

Southwestern Willow Flycatcher:

The southwestern Willow Flycatcher (*E.t. extimus*) is a federally listed endangered species. For projects within this subspecies' range in the far southern Sierra Nevada, the appropriate protocol requires 3 to 5 visits between May 15th and July17th.

Sogge, M. K., D. Ahlers, and S. J. Sferra. 2010. A natural history summary and survey protocol for the Southwestern Willow Flycatcher. U.S. Geological Survey Techniques and Methods 2A-10. http://pubs.usgs.gov/tm/tm2a10/

Black Rail

The Black Rail is listed as threatened under the California Endangered Species Act and was recently discovered to occupy not only brackish, coastal and delta habitats but also small, fresh-water marshes in the foothills of the Sierra Nevada (Richmond et al. 2008). Evens et al. (1991) recommend broadcast surveys between March 15 and May 31. Surveys for this species are only warranted at elevations where hard freezes rarely occur (generally below approximately 3000 ft/915 m in elevation); the species is absent from sites at higher elevations.

Evens, J. G., G. W. Page, S. A. Laymon, and R. W. Stallcup. 1991. Distribution, relative abundance, and status of California Black Rail in western North America. Condor 93(4):952-966.

VII. PERMITTING

In developing this protocol we designed our sampling strategy to ensure that all activities are in compliance with the National Environmental Policy Act (NEPA), the California Environmental

Quality Act (CEQA), the California Endangered Species Act (CESA), and various state and federal agency permitting policies. It is our assumption that all such monitoring under this protocol will be carried out by the authorized agency or private landowner, their consultant, or a permitted volunteer. As such, we assume that all permitting and NEPA/CEQA compliance is being met for restoration activities. Because point counts, area searches and vegetation plots do not require handling or disturbing wildlife or plant resources, special permitting is not necessary unless the monitoring is being conducted by an outside entity (conservation organization, university, private individual, etc.). In those cases, permission should be secured well in advance of starting the survey, and land management agencies may require the formal request of a research or collection permit. Department of Fish and Game regional staff may also need to be notified prior to these surveys. See http://www.dfg.ca.gov/regions/ for more information. Finally, it is always recommended that, in addition to obtaining prior permission, individuals check in with the local public land office (e.g., FS Ranger District) on arrival.

In some cases, broadcast surveys can disturb individual birds. For this reason, these surveys may constitute "take" as defined under the California Endangered Species Act as well as Fish and Game Code sections 3503 and 3513, and CCR Title 14 251.1 pertaining to protection of birds and nests. Broadcast surveys therefore sometimes require a Scientific Collecting Permit (SCP) and Memorandum of Understanding (MOU) from the California Department of Fish and Game. Because Willow Flycatchers are state endangered, broadcast surveys targeting them require an SCP and MOU. Similarly, if restoration project managers wish to conduct broadcast surveys for other protected species (e.g., Black Rail, Great Gray Owl), an SCP and MOU are also required. If broadcast surveys are limited to species that are not considered sensitive, threatened, or endangered, an SCP may not be necessary, as long as broadcast surveys are not conducted in areas where they might disturb non-target protected species. For example, broadcast surveys for Soras could result in responses from - and disturbance to - Black Rails. Therefore, broadcast surveys for any rail species within known Black Rail habitat might require a permit.

We strongly recommend assessment of survey sites for unintended impacts on protected species, and consultation with appropriate agencies. If state permits are deemed necessary, note that MOUs are linked to restoration projects (and issued to the principal investigator associated with the project) while SCPs are linked to the individual conducting the survey, not to the project itself. California Department of Fish and Game recommends requesting MOUs and/or SCPs at least six months prior to the start of the survey to ensure that permits are issued on time.

For information on applying for a scientific collecting permit from the California Department of Fish and Game: *http://www.dfg.ca.gov/wildlife/nongame/research_permit/scp/scp_aplic_procs.html*

VIII. PERSONNEL CONSIDERATIONS AND TRAINING

Personnel requirements for this protocol vary greatly depending on the number and size of sites being monitored.

Based on information collected during a 2010 trial of this protocol, a single observer can conduct point counts, along with the associated area search, at approximately 8-10 survey stations within the allotted 4 hours after local sunrise. For maximum efficiency, we recommend that after those efforts are complete, the same observer should conduct vegetation monitoring. Many restoration sites are only large enough to accommodate 6 or fewer point count stations; at larger sites where qualified personnel are limited, multiple mornings (on consecutive days, if possible) may be required to complete a visit. In this case it may be more efficient to complete the point counts on one or more days, and then the area searches during one or more other days.

Surveying birds at a Sierra Nevada meadow slated for restoration work. (L. Vormwald)

Field technicians who conduct point counts and broadcast surveys should have prior birding or bird survey experience and be able to identify the songs and calls of all bird species likely to occur at the site. Experience conducting point counts is also desirable.

A comprehensive and well-designed training program is critical for training new observers, as it will maximize observer consistency – both within and between years. Training should provide instruction in the following topics:

- Bird identification by sight and sound
- Conducting point counts
- Conducting broadcast surveys
- Area searching
- Basic plant identification and cover estimation
- Estimating distances to birds
- Completing field forms
- Orienteering and collecting GPS data

Proficient bird identification by sight and sound requires practice, and even experienced birders benefit from annual pre-survey review. We recommend providing surveyors with audio devices loaded with songs of the species likely to occur in the project area or in the Sierra Nevada at large. Appendix F provides a list of bird species that regularly occur in the Sierra Nevada during spring and summer, and Table 2 (above) provides a list of potential meadow-associated focal species – those most likely to respond to restoration efforts.

Optimally, less experienced surveyors will listen to and study recordings well in advance of the field season. During the two-week period just prior to surveys, we recommend early-morning visits to local meadows, where surveyors-in-training can hone their identification skills and familiarize themselves with the local dialect variations that exist for some bird species.

Regardless of whether project managers opt to estimate the exact distance to each bird or merely to determine whether each bird is within a 50-m radius of the survey station, estimating distances to birds requires

training and practice. At a minimum, surveyors must have the ability to reliably recognize the 50-m distance in both open meadow and dense shrubby settings. This skill can best be developed by making practice distance estimates and then using a laser range-finder to test the estimates. Practice point locations within differing meadow vegetation communities should be selected and surveyors should measure 50 m in the four cardinal directions and mark the distance with flagging. After a good visual image has been secured in this way, surveyors should practice estimating distances to objects and then measuring to assess the accuracy of those estimates.

Once surveyors are proficient at bird identification and estimation of 50 m, practice implementing the point count protocol is valuable. An ability to identify birds is necessary but may not be sufficient to successfully conduct point counts. We strongly recommend that surveyors conduct practice point counts until they become comfortable with the protocol.

IX. DATA VETTING AND ARCHIVING

Data should be entered as soon as possible after each field visit to ensure mistakes or oversights are caught and corrected, and inadvertent deviations from the intended protocol are not propagated over multiple visits. We recommend entering data into the Microsoft Access database structure "Sierra Meadows Avian Monitoring Database" available at The Institute for Bird Populations website: http://www.birdpop.org/Sierra/sierra_meadows.htm.

We recommend that data are processed in the following sequence (adapted from Cook and Lineback (2008):

1) *Archive raw data* – Photocopies or scanned pdf documents of all completed data forms are archived.

2) *Enter data* – Data are entered into the working database.

3) *Verify, process, and validate* – Accurate transcription of the raw data is verified; data are processed to remove duplicate records or other flaws; and data are validated through visual inspection and queries to capture missing data, out-of-range values, and logical errors.

4) *Documentation and certification* – Any needed metadata are developed or updated and the data set is certified. Certification is a confirmation by the project leader that the data have passed all quality assurance requirements and are complete and documented.

5) *Archive versioned data set* – The certified electronic data set is saved, with a unique version number, in a permanent location.

6) *Disseminate data* – The certified, versioned data can now be shared as desired with project partners, other researches, or appropriate data clearinghouses such as the California Avian Data Center (CADC; http://data.prbo.org/cadc2/), a regional 'node' of the Avian Knowledge Network (AKN).

7) *Reporting and analysis* – Certified data are used to generate data products, analyses, and reports.

8) *Track any post-certification changes to the data set* – Any subsequent changes to certified data are documented in an edit log, which is archived with the project data set. Significant edits may necessitate disseminating the revised data set (see step 6).

9) *Archive products* – Reports and other data products are archived along with the project data set.

X. DATA ANALYSIS AND REPORTING

Compiling and reporting results is a critical component of monitoring, and we strongly recommend producing a report – even a brief one – to tabulate and summarize results after each year that surveys are conducted. Here we provide some examples of metrics to report, and a template for reporting them. However, appropriate analysis and reporting for a particular project may range from simply compiling a species list to sophisticated modeling efforts aimed at estimating detection probability and occupancy probability of target species. Critical questions to ask when planning analysis and reporting efforts include:

- Who is the intended audience for the report? Whether the report is intended primarily for the general public, project funders, local land managers, the broader scientific community, or perhaps other audiences, should influence the contents and format of the report.

- Are there project-specific management questions that require particular analyses? Particularly when reporting is intended primarily to meet the needs of local land managers, data analysis and presentation should be driven largely by the questions and information needs *of the local land managers*.

- Are there project-specific species of concern that merit special attention in the reporting?

Regardless of individual project needs, annual reports should always provide basic information describing the scope of monitoring activities that were completed (number of visits, number of survey stations, etc.), when and where the surveys were conducted (including station coordinates, maps, and photos if possible), who conducted them, and what specific methods were used (if this standardized protocol is used, the protocol may be referenced in lieu of a detailed description of methods). **Appendix H provides sample tables and maps for reporting results from point count surveys, area searches, and habitat assessments.**

Future versions of this protocol will provide guidance on assessing change over time in bird community composition and population-size indices at restoration sites.

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XII. Appendices

APPENDIX A

Establishing Survey Stations

If possible, monitoring sites should be assessed using topographic maps, GIS software, and any available satellite imagery prior to the first survey visit. This will allow the observer(s) to know the size and shape of the site, approximately how many survey stations will be necessary for complete coverage, and how many observers will likely be required. Survey stations can also be delineated at this time following the same rule set described below for establishing survey stations in the field. The location of survey stations may have to be adjusted in the field due to factors not ascertainable from remote-sensed imagery; a pre-survey field visit can therefore be very helpful. Survey stations described here will be used for conducting point counts (Appendix C), broadcast surveys (Appendix D), and vegetation assessment (Appendix G).

Prior to the morning of the first bird survey, an initial walking survey of the meadow boundaries, stream locations, and any pre-determined survey stations is highly recommended. If no GIS imagery was used prior to the first site visit, this field visit is imperative to determine if the meadow has multiple stream courses and stringer meadows occurring out of sight from the main meadow opening.

All distances between successive survey stations and between survey stations and the meadow edge should be estimated using GPS technology and laser rangefinders, if available. As each survey station location is delineated it should be marked with temporary flagging and recorded on maps and with GPS. The flagging should include the station number, site name and date. If possible, the flagging should remain until at least the first survey visit. At some sites it may be possible to retain the flagging for the second visit, but all flagging should be removed at the end of the second visit. Check with landowners or land managers for local rules regulating whether or how long flagging can be left in place.

Determining survey station locations

The first step in establishing station locations is to determine the “origination point” - the place where the primary stream channel flows OUT of the meadow. The origination point location should be recorded on a GPS unit or map. From the origination point, determine a compass bearing that parallels the general course of the primary stream channel. This will be the transect along which stations will be placed (with adjustment for stream buffers). The transect does not need to meander in and out along the stream, but rather can follow the general direction of the stream (Figure A-1). Select a random number between 25 and 75; place the first survey station this many meters upstream from the origination point, along the stream transect. Remaining stations should then be systematically placed upstream of that location, such that stations are evenly spaced 250 m along a transect that parallels the primary stream course (or the

channel upon which restoration is planned). The primary stream channel should be buffered such that survey stations are placed at least 25 m from the stream itself. If any survey station falls within 25 m of the stream, the station should be moved at a 90 degree angle from the transect to the closest location outside the 25-m stream buffer. The 25-m buffer is intended to alleviate issues associated with stream noise during point counts, as well as to lessen the likelihood that survey stations will be placed in locations that could be permanently inundated with water after restoration activities are complete. Survey stations that are inundated with water in subsequent years could be difficult to access, making replication of monitoring data a challenge. The transect or individual stations should also be placed such that they are at least 25 m from the meadow edge when possible. In situations where the meadow is narrow and linear (<100 m wide), stations can be placed every 250 m along a transect that follows the center of the long axis of the meadow, regardless of where the stream channel is located.

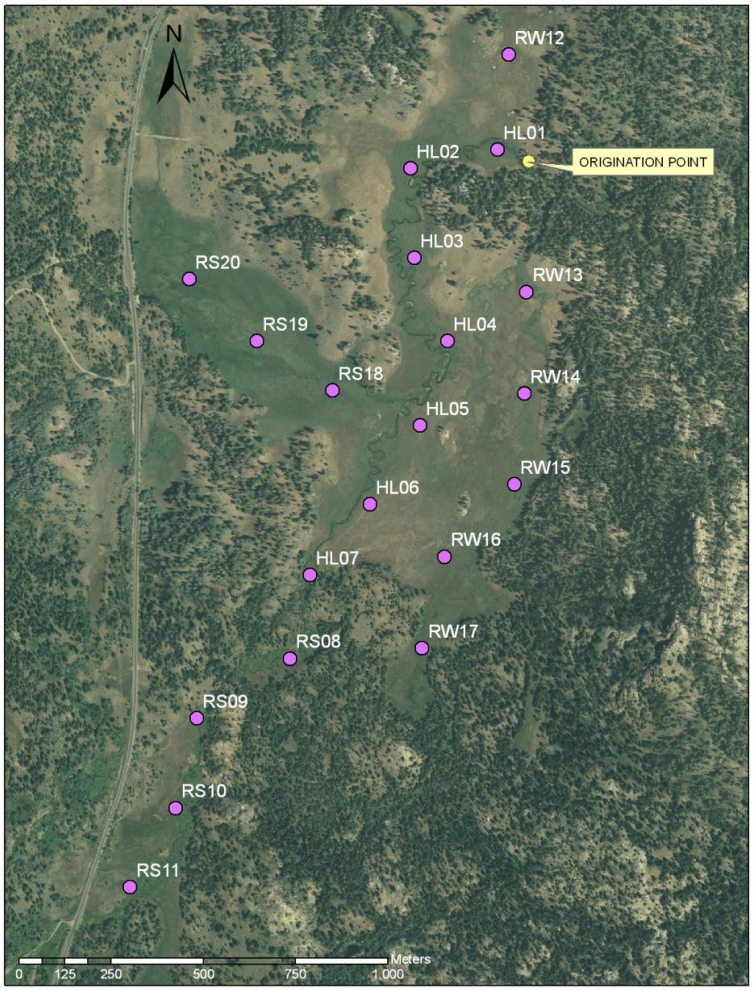


Figure A-1. Example of survey station placement at Red Lake Creek, Alpine Co., CA. Purple circles are bird survey stations, labeled with the meadow-specific station codes assigned to them. The origination point (yellow circle) indicates where the primary stream channel flows out of the meadow, and is useful for determining where to place the survey stations (see text).

Once the first transect along the primary stream channel has been established, determine whether additional areas of the meadow are greater than 250 m from existing survey stations. If this is the case, additional survey stations should be established to survey these areas. These additional survey stations can be established in a number of ways, including:

- along a transect following a tributary to the primary channel from the location where it flows into the primary channel.
- along a new transect that parallels the original primary transect at a distance of 250 m.
- single point-by-point placement in pockets of the meadow not covered by existing survey stations.

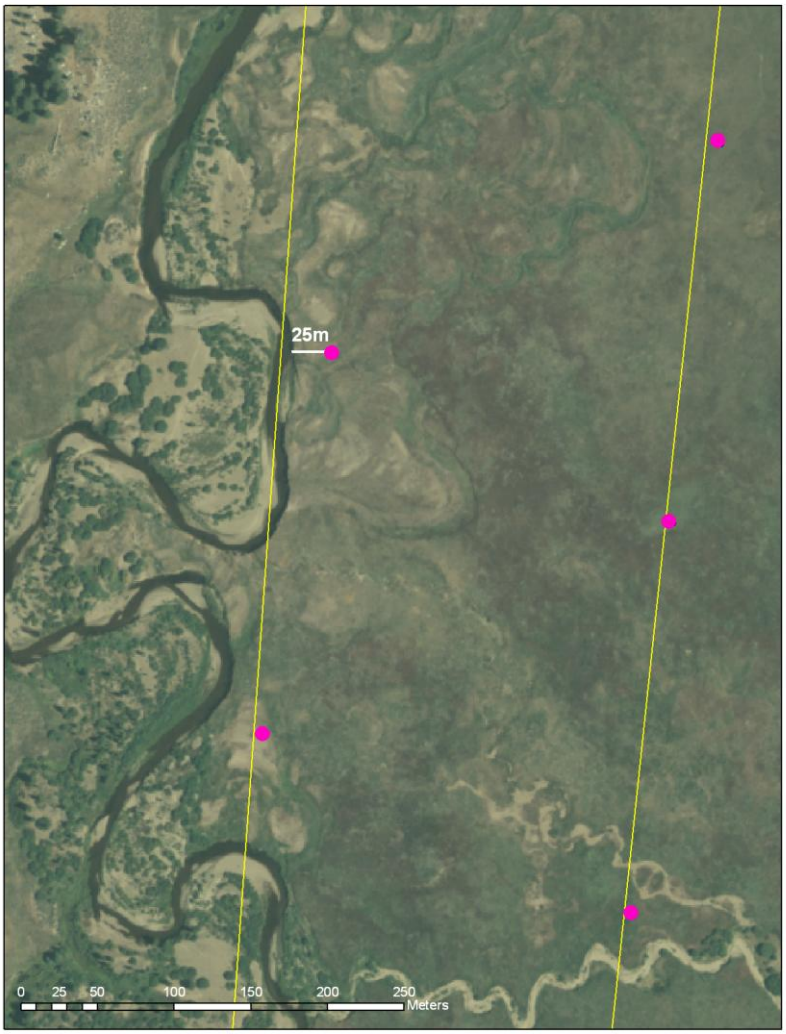
If a survey station falls at a location that is:

- deep within a shrub patch such that visual ID in all directions would be significantly impaired,
- close to a stream or road that is loud enough to substantially interfere with bird surveys, or
- in a dangerous location (perhaps requiring a difficult stream crossing),

the survey station should be moved to the closest location that alleviates the problem. Any changes to previously delineated survey stations should be noted on the data forms with an updated GPS location, written description, and map notation.

An example survey station layout is shown in Figure A-1, above, which depicts the Red Lake Creek site in Alpine County. In this instance the origination point is at the north end of the meadow where the main channel of Red Lake Creek flows out of the meadow to the east. The first station is placed 32 m upstream of the origination point. This distance was generated using a random number table (values between 25 and 75 meters). Point HL02 was placed 250 m upstream from station HL01, and from that location survey stations were placed along a straight line transect that roughly follows the stream, with adjustments made to stations to ensure they were at least 25 m from the meadow edge and stream. For example, point HL04 on the photo was adjusted to the east of the transect to avoid placement within 25 m of the stream. Once stations were placed along the entire distance of the main channel within the meadow (through point RS11), points where then placed along two tributaries that occurred to the east and west of the original transect (points RW13 through RW17, and points RS18 through RS20, respectively). After all survey stations were placed along stream channels, the remainder of the meadow was examined to determine if any areas of meadow vegetation were more than 250 m from an existing survey station. At Red Lake Creek, one additional station (RW12) was required for complete coverage at the north end of the meadow. Figure A-2 depicts another situation where the transect bearing and 250 m station spacing would result in a survey station occurring directly over the streambed. In this case the station was adjusted to a distance of 25 m from the stream.

Figure A-2. Close-up of survey station layout with adjustment for 25-m stream buffer in Upper Hope Valley, Alpine Co., CA. Purple circles indicate bird survey stations and yellow lines indicate the bearing – which follows the general stream course - on which the stations were established. One station needed to be adjusted 25 m to the east to avoid placement in or too close to the stream.



Special circumstances: very small and very large meadows

When establishing survey stations it is important to remember that all meadows and projects are different and sometimes the method for establishing stations described above will need to be adjusted. In circumstances where meadows are very small and 4 or fewer survey stations would be established using 250 m spacing, it may be beneficial to reduce the survey station spacing to 200 m. Even one additional survey station could dramatically improve the statistical power of future measures of population change. If the decision is made to reduce spacing to 200 m, then all stations should have the same consistent spacing at that site. In addition, this difference in spacing should be recorded on the survey station location form.

Sometimes very large meadows that are many hundreds of acres in size may have a restoration project that is designed to treat only a small portion of the meadow. In situations where this is the case it may be beneficial to designate the origination point at the location where the main channel leaves the downstream end of the project area, and then identify survey stations as described above. We recommend using caution when restricting survey stations in this way because during planning the project boundaries may change. Additionally, unforeseen effects of restoration may arise in areas far from the restoration activities. In general, it is better to be liberal in establishing survey stations than to find out too late that affected areas are not covered by the existing stations.

Naming conventions for meadows and survey stations

Many meadows already have established names. For unnamed meadows we recommend using the name of the stream that flows through the meadow, the closest named stream to which it is a tributary, or other prominent landmarks. For meadows with long names we advise creating standardized 4 to 6 digit abbreviations prior to the field season. This practice will help to avoid subsequent confusion caused by multiple observers creating varying abbreviations (especially if multiple similarly named sites are being monitored).

We recommend naming each survey station with a unique (for each meadow) 4 digit alpha-numeric code, which will facilitate using the database structure that we developed to accompany this protocol. The following system has worked well for us: the first two characters are the first and last initials of the observer who first surveys the stations, and the third and fourth characters are numbers, proceeding sequentially from 01 at each meadow (i.e.; HL01, HL02…). If more than one observer is required to cover the site in a single morning, observers should assess the site in advance and determine how to divide the site efficiently. Each observer will use his/her initials in the survey station name and the appropriate sequential number. If survey stations were not identified in advance using GIS, and more than one person surveys the site, they will both number their stations starting at “01”. In this case it is important that they use their initials as well to avoid confusion related to multiple survey stations with the same number.

Required equipment

- Clip board
- Data forms
- Maps and aerial photos of site
- UTM coordinates of survey stations
- Pencils
- GPS unit
- Compass
- Flagging tape
- Permanent marker
- Laser range-finder (optional)
- Rubber boots or waders (optional)

Completing the Survey Station Location Form: field definitions and instructions

Once the survey station has been located and marked with a vinyl flag, complete the form as follows:

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary. For sites with long names, we advise creating standardized 4 to 6 digit abbreviations prior to the field season. This practice will help to avoid subsequent confusion caused by multiple observers creating varying abbreviations (especially if multiple similarly named sites are being monitored).
- **GPS model**: Record the model and make of the GPS unit used.
- **GPS file**: If GPS data are being stored on the unit, record the file name.
- **Restoration/Reference**: Circle whether this meadow is a restoration site (where restoration is planned or has occurred) or a reference site.
- **Navigation:** Circle whether survey station were located using a Map/Photo or GPS.
- **Zone:** Enter the UTM zone in which the point location was collected and confirm that the GPS unit is recording coordinates in the NAD83 datum.
- **Distance between stations:** Record the distance between survey stations in meters. This value should be 250 m unless "special considerations" (described above) apply.

After the top of the form is completed, record the following information for the origination point (where the stream leaves the meadow) and all survey stations:

- **Survey station number:** All survey stations should be given a 4 digit alpha-numeric code; the first two digits should be the observer's first and last initials and the second two digits should be sequentially numbered from 01-99 (i.e.; HL01, HL02…).
- **UTM northing**: Enter the 6 digit UTM northing coordinate (omit any preceding zeros)
- **UTM easting:** Enter the 7 digit UTM easting coordinate (omit any preceding zeros)
- **PDOP or GPS error:** If using a GPS unit to determine the location, record either the PDOP, or error in meters, to indicate accuracy of the coordinates.
- **Transect bearing**: If using a compass to navigate from station to station, provide the compass bearing (declination set at true north) of the transect to the next point.

- **Comments**: Record comments about landmarks to help relocate the point and especially about obstacles between points. Provide direction on maneuvering around obstacles. When lengthy, comments may be written on the back of the page and numbered. The comment number would be written in the comment field on the front of the data form.

Survey Station Location Form

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Observer:__________________________ **Date:** ________/_______/__________

Forest/Park/County:_______________________ **Meadow:**_______________________________________

GPS Model:____________________ **GPS file:**______________________ **Site type** (circle one): **Restoration / Reference**

Navigation: Map/photo or GPS **Zone:**__________ **(NAD83)** **Distance between stations**____________

Station #[1]	X – coordinate UTM Easting	Y – coordinate UTM Northing	PDOP or GPS error (m)	Transect bearing	COMMENTS Obstructions? Landmarks?
Origination point	___ ___ ___ ___ ___ ___	___ ___ ___ ___ ___ ___ ___			
	___ ___ ___ ___ ___ ___	___ ___ ___ ___ ___ ___ ___			
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The first station is determined using a random distance between 25-75 m along a compass bearing following the general course of the stream. Distance and bearing of 1st station are measured from the origination point where the primary stream channel flows out of the meadow. All subsequent points are 250 m apart, unless they meet "special considerations" described in instructions.

APPENDIX B

Assessing Site Conditions and Recording Site Summary Information

This protocol assesses the site conditions at the time of each visit and records a summary of which survey protocols were completed during the visit (point counts, vegetation assessments, etc.). This protocol is applied to the entire survey area, unless the site has been divided between multiple surveyors. In that case, each surveyor will record the information for her/his portion of the meadow on a separate form. With the exception of the weather conditions that are recorded at the start of the surveys, all other data may be recorded at the end of the visit, after bird surveys are complete. We recommend allowing approximately ¼ - ½ hour for completion of the site conditions and summary form at each meadow. Training and practice will help streamline data collection, maximize consistency between surveyors, and greatly improve the accuracy of ocular estimates of cover.

Upon arrival at the meadow site, record the meadow name, codes and location coordinates, as well as the weather conditions. After all bird surveys are complete for the visit, record the ending weather conditions and complete the vegetation assessments for each station. When done, complete the remainder of the *"Assessing Site Conditions and Site Summary Information"* form. This will include listing all survey protocols that were completed during the visit and recording which survey stations were surveyed during the visit. Once this portion of the form is complete, record information under the subheading: "*Meadow Phenology at Time of Each Visit"*. These fields include estimates related to vegetation phenology, the amount of snow present, and over bank flooding occurring at the time of the visit. These data provide information on the likelihood of whether individual species would be breeding at the time of the visit. The final section of the form under the subheading "*Site Description (record once per season)*" includes ocular estimates of general vegetation communities at the site and either an ocular estimate or GPS-based measurement of the meadow size. Care should be taken to record cover estimates of general vegetation types with no overlap, so that the total of all types equals 100%. It is not necessary to try to determine how much herbaceous cover occurs under shrub cover, rather ignore the understory and include this area only in the shrub cover estimate. Optimally at least 1 photograph should be taken at each survey station, and at a minimum 1 per meadow. We recommend taking photographs after each vegetation assessment (Appendix G), to avoid spending time recording photo information during the bird survey period.

Required Equipment:

- GPS unit
- Clipboard
- Data forms
- Maps and aerial photos of site
- Pen or pencil
- Camera

Completing the Site Conditions and Site Summary Form: field definitions and instructions

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary. For sites with long names we advise creating standardized 4 to 6 digit abbreviations prior to the field season. This practice will help to avoid subsequent confusion caused by multiple observers creating varying abbreviations (especially if multiple similarly named sites are being monitored).
- **Meadow quad code** (not strictly necessary): Enter the 7 digit USGS quadrangle code plus a 3 digit sequential number designating whether it is the 1st, 2nd, 3rd, etc, meadow surveyed in this quadrangle (example: 39120D3_001).
- **Restoration/Reference**: Circle whether this meadow is a site where restoration is planned/has occurred, or a reference site.
- **UTM Northing**: Enter the 6 digit UTM northing coordinate for the approximate center of the meadow (omit any preceding zeros).
- **UTM Easting:** Enter the 7 digit UTM easting coordinate for the approximate center of the meadow (omit any preceding zeros).
- **Zone:** Enter the UTM zone in which the location was collected and confirm that the GPS unit is recording coordinates in the NAD83 Datum.

Record the following conditions at the start and end of bird monitoring during each visit to the meadow.

- **Temperature (F):** Record the temperature at the start of the count in Fahrenheit.
- **Wind (0-6):** Record the wind conditions during the survey visit using the following codes:

Wind Code (Beaufort Scale)	Explanation
0	Calm; smoke rises vertically (<2 km/h)
1	Light air; smoke drifts (2-5 km/h)
2	Light breeze; wind felt on face, leaves rustle (6-12 km/h)
3	Gentle breeze; leaves and twigs in constant motion (13-19 km/h)
4	Moderate breeze; small branches move; raises loose paper; dust rises (20-29 km/h)
5	Fresh breeze; small trees sway (30-39 km/h)
6	Strong breeze; large branches moving, wind whistling (40-50 km/h)
Wind stronger than this precludes point counts.	

- **Rain (1-3):** Record the rain conditions during the survey visit using the following codes:

Rain Code	Explanation
1	No rain.
2	Mist or fog.
3	Light drizzle.
Rain stronger than this precludes point counts.	

- **Clouds (%):** Record percent cloud cover within the portion of the sky that is visible to you. This should be a number between 0 (no clouds) and 100 (complete overcast). If there are patches of clouds in different areas of the sky, try to image gathering all of them together into one part of the sky and recording what percent of cloud cover that would represent. On hazy mornings it can sometimes be difficult to decide whether cloud cover is 100% or 0% - in such instances record 100%.
- **Monitoring Activities Completed:** Record which of the 4 site visit components were completed, and for which stations, and list stations and photo numbers for any photos taken.
- **Meadow Phenology at Time of Each Visit:** Record the phenological status of meadow conditions at the time of visit. Record the percent of each vegetation type that is dormant, partially leafed out, fully leafed out, or fading (should total 100%). Also record if vegetation is flowering.
- **Snow Present at Time of Visit?**: Record a Y or N to indicate if snow is present or absent within the meadow or within the immediately adjacent uplands at the time of visit.
- **Percent of Meadow Covered by Water**: Record the percent of the meadow surface that is covered by flowing or standing water.
- **Flying insect abundance**: Record average flying insect abundance during the morning survey period on a scale of 0 to 10. A value of “0” means that no flying insects are present and a value of “10” means that there are numerous taxa present and in such high numbers that they are consistently in the observer’s eyes, nose, and m

Site Description: record the following metrics only once per season

- **Percent of Site by Vegetation Type**: Estimate the percent of meadow dominated by each vegetation community. Total should equal 100%.
- **Primary Adjacent Upland Community**: Record the adjacent upland vegetation community that is most dominant at the site.
- **Signs of Beaver Activity**: Record a “Y” for yes or “N” for no. North American beavers are rarely observed directly at a meadow but signs of their presence are usually identifiable. Recent dams across small to medium-sized streams or tributaries are made up of small willow, aspen, or other branches combined with other plant material and mud. Lodges are large mounds of branches near or within an area of ponded water, or sometimes just next to the stream bank. Lodges are usually approximately 1-2 m in height and at least 2 m in diameter.

Cutting of willow or other shrubs by beaver can be differentiated from livestock or ungulate browsing by the sometimes large areas of stems being cut with a uniform sharp angle (versus nipping of the stem ends only by browsers). Similarly, whole trees near the stream will be felled leaving the tell-tale stump that looks like a sharpened pencil.

Site Conditions and Site Summary Form

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Observer:_____ Date:_____/_____/_____

Forest/Park/County_____ Meadow Name:_____

Visit # _____ Meadow quad code:_____ Restoration or Reference? (circle one)

Meadow Center Easting:___ ___ ___ ___ ___ ___ Northing:___ ___ ___ ___ ___ ___ ___UTM zone:_____NAD 83

Starting Temp: F / C Wind: Rain: % Clouds: .

Ending Temp: F / C Wind: Rain: % Clouds: .

Monitoring activities completed

Point Count Survey completed? (list station numbers)	*Broadcast Survey? (Y/N) (list species broadcast)*	*Area Search? (Y/N)*	*Vegetation Cover Quadrants? (List stations)*	*Photos? (list station & photo numbers)*

Meadow phenology at time of visit:

Vegetation type	*% dormant*	*% leaves emerging*	*% fully leafed out*	*% leaves fading*	*flowering Y/N?*
Herbaceous vegetation					
Riparian shrubs					
Deciduous trees					

Snow present at time of visit (Y/N)? In meadow?_____, in uplands (w/in 50m of meadow)?_____

Percent of meadow surface covered by water at time of visit_____

% Flying insect abundance during visit (0-10 scale) _____, (0 = absent and 10 = chokingly thick w/ many taxa)

Site Description (record once per season)

Percent of Site in Each Vegetation Type	*% Cover*
open meadow(dominated by herbaceous vegetation)	
riparian shrubs	
sagebrush	
conifers (not including overhanging cover along edge)	
Other_____	
Total	100%

Primary adjacent upland community (conifer/hardwoods/sagebrush/west-side chaparral etc)_____

Signs of Beaver activity: **lodges, dams, cut stems** _____(Y/N)

APPENDIX C

Conducting Point Counts

This survey utilizes 7-minute point counts, divided into three shorter time intervals. All birds are can be classified as being less than or more than 50 m from the observer at first detection, or for surveyors skilled at distance estimation, the exact distance to each bird at first detection can be estimated. At each survey station the observer will record each individual bird detected on a separate row of the data form. The horizontal distance to the bird or the distance category (≤50 m or >50 m) at the time of first detection will be noted and then the observer will indicate whether that individual bird was detected during each of the 3 time intervals by circling only those intervals in which the bird was detected. The observer will also document whether the bird was heard singing during at least one of the 3 time intervals (as opposed to identification based strictly on visual observation or calls other than the species' typical territorial song).

Required Equipment

- Binoculars
- Watch with stopwatch function
- Clipboard
- Data forms
- Maps and aerial photos of site
- UTM coordinates of point count stations
- Pencils
- Field guide to western birds
- GPS unit
- Compass
- Flagging tape
- Permanent marker
- Laser range-finder (optional but highly recommended)
- Rubber boots or waders (optional)

Completing the Point Count Form: field definitions and instructions

Once the survey station has been located and marked with a vinyl flag, prepare to conduct the point count. Make yourself comfortable by taking off your backpack and situating binoculars so that they are in a comfortable and accessible position around your neck. Place the point count data form on the top of your clipboard and complete the top portion of the form as follows:

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary. For sites with long names, we advise creating standardized 4 to 6 digit abbreviations prior to the field season. This practice will help to avoid subsequent confusion caused by multiple

observers creating varying abbreviations (especially if multiple similarly named sites are being monitored).

When you are ready, set your stop-watch and begin the count. During the 7-minute point count, record data as follows:

Station No.: Enter the 4-character code for the survey station. The first two characters are the observer's first and last initial. The third and fourth characters indicate the sequential order of the survey station along the transect that parallels the primary channel (e.g., the first station surveyed upstream of the origination point would be HL01; the second station would be HL02, etc.). Additional stations that occur off the primary channel, on either parallel transects, on tributaries, or independently where needed to ensure complete site coverage, should be numbered sequentially in the order most logical for surveys. For each station, write the station number on the first row of data (describing the first bird detection) only. This space may be left blank for subsequent detections at the same station.

Start Time: Record the 4-digit time of day the point count began (e.g., 0620). For each station, write the start time on the first row of data (describing the first bird detection) only. This space may be left blank for subsequent detections at the same station.

Species: Enter the 4-letter bird species code (refer to Appendix F for a complete list of 4-letter species codes). Juvenile birds should not be recorded on the data form. It can be difficult to age birds during point counts but in general you should count a bird unless you are confident it is a juvenile. Juvenile birds are defined as birds that hatched during the current breeding season. Clues to look for which may indicate a juvenile bird include: the presence of interacting family groups of birds, birds wearing juvenal plumage, weak-flying birds, and birds that are begging from or being fed by parents. Be familiar with the typical signs of young birds; species-specific plumage varies but in general look for downy, fluffy plumage that often appears quite different from that of an adult of the same species, a fleshy gape (often bright in color and contrasting with the bill color), and heavy body molt (plumage will look unusually messy with new body feathers growing in and replacing downy pre-juvenal feathers). Once birds have dispersed from the immediate breeding area it can become much more difficult to identify a young bird. The seasonal timing of this survey should ensure that juvenile birds are encountered rarely, except at higher elevations, where upslope-dispersing birds that hatched at lower elevations may appear before the local young have fledged.

Est. Distance or ≤ 50m? (Y/N): 'Y' indicates the bird was observed or detected within 50 m of you at the time it was first detected. 'N' indicates the bird was first detected at a distance of greater than 50 m, even if it subsequently moves to a location <50 during the 7-minute duration of the count. *[Alternately, if the project leader desires estimates of exact distance to each bird, this field can be used for that purpose. Rather than filling in a "Y" or "N", estimate the distance of the individual at the time of first detection to the nearest meter (avoid rounding up or down to the nearest 5 or 10 m, especially when birds are <100 m away).The use of a laser range-finder can be very helpful – if one is*

available, measure the distance to prominent landmarks before starting each point count, then use that information to contextually estimate distances to birds. Record distances or distance classes for all birds except individuals or groups classified as 'flyovers' (see below).

Time Interval: Circle each time interval during which the bird was detected. For example, if the bird was only detected during the first and last intervals leave the second and third intervals uncircled. Actual time intervals are as follows:

- 0-3: from the time the stopwatch starts until 2 min and 59 sec elapse
- 3-5: from 3 min until 4 minutes and 59 sec elapse
- 5-7: from 5 min until 6 minutes and 59 sec elapse

Ever Sang (Y/N): 'Y' indicates the bird sang at least once during the 7-minute point count. 'N' indicates the bird did not sing during the 7-minute point count. Most songbirds have a typical song that is distinct from its calls. An example is the Black-headed Grosbeak, whose song can be described as a high, drunken, rolling warble and whose call is a high, sharp *pik* note. Groups of birds likely to be encountered in the field that have less well-defined songs and calls include hawks and falcons, grouse and quail, owls, woodpeckers, flycatchers, and jays and crows. The general rule to follow for distinguishing between songs and calls for all species is to defer to vocalization descriptions in The Sibley Field Guide to Birds of Western North America, with a few clarifications, as described below. If in doubt as to whether a particular species actually "sings" record their vocalization as a song.

- Hawks and falcons: Never sing - regard all vocalizations as calls.
- Grouse and quail: Low hoot of Sooty Grouse classified as song, all other vocalizations classified as calls. *Quark* of Mountain Quail and *Chi ca go* of California Quail classed as songs, all other vocalizations are calls.
- Owls: Songs are defined as the typical series of hoots a male defending territory would give (sometimes referred to as 'location calls'). This does not include any of the female and juvenile calls or other sounds made by males (sometimes referred to as 'contact calls').
- Woodpeckers: Songs are limited to rattles for most species. Calls are defined as all contact calls, drumming and any other vocalizations. For Northern Flicker and Pileated Woodpecker the similar sounding *wuk wuk wuk wuk wuk* vocalizations are classified as songs; all other vocalizations are calls.
- Flycatchers: Well-defined by Sibley. Typical two- and three-note vocalizations from *empidonax* flycatchers are classified as songs.
- Jays and crows: Never sing - regard all vocalizations as calls.

Prev. Obs.: Enter 'Y' to indicate that the same individual bird was recorded at more than one survey station and then record the station number. The 'Y' should be associated with the count on which the individual was at a greater distance from the observer. Otherwise this field should be left blank.

Flyover: 'Y' indicates the detection was a 'flyover'--a bird or birds that flew over the top of the vegetation canopy, never touched down in the observer's field of view, and did not appear to be foraging, displaying, or behaving in any other way that might suggest a link to the habitat below. The space should simply be left blank when the detection is not a flyover.

Group Size: A blank field indicates a single individual, whereas a numerical entry indicates the number of birds in a flock. Landbird species for which group size entries may be greater than one are limited to typically flocking species - swallows, Cedar Waxwing, Red-winged Crossbill, Evening Grosbeak, Pine Siskin, Gray-crowned Rosy-Finch, and late-season, high-elevation aggregations of Golden-crowned Kinglet and Dark-eyed Junco. Even for these species, only record birds together as a flock if they are clearly behaving as a flock. Multiple birds singing in the same general area, or chasing each other do not qualify as a flock and each individual should be recorded on a separate line of data. For all other landbirds, even if you see multiple individuals moving together or interacting, provide a separate line of data for each individual. Note that clusters of individuals of species that do not normally flock may be post-fledging family groups, in which case the juveniles should not be counted. At sites occurring along lake margins or large wetlands shorebirds of numerous species may be recorded as flocks.

Comment: Use this field only for essential comments about particular bird detections, such as noting any uncertainty about species identification. If a comment is lengthy, write it on the back of the form and number it. Then write the comment number in the comment field.

2. Miscellaneous things to keep in mind while conducting point counts

- Approach each survey station as quietly as possible. If you need to repack your things or add or remove clothing, try to postpone doing so until after the point count.
- Be sure to periodically rotate your body so that you do not spend the entire point count facing the same direction; you must do your best to track birds around you in all directions.
- Try to keep track of individual birds, so that if they move you will not mistake them for additional individuals.
- Do not forget to record the common species - they are easy to tune out as you are concentrating on detecting and identifying rarer species. Remember that the objective is to detect as many of the species occurring in the meadow as is possible.

Point Count Form

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Observer:_____ **Date:**_____/_____/_____

Forest/Park/County:_____ **Meadow Name:**_____

Station No.	Start Time hh:mm	Species code (4 char)	Est. distance (m) or ≤50 m (Y/N)	Time Intervals	Ever Sang? (Y/__)	Prev. Obs. (Y/__)	Flyover (Y/__)	Group size	Comment
				0-3 3-5 5-7					
				0-3 3-5 5-7					
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APPENDIX D

Conducting Broadcast Surveys

Immediately following each 7-min point count, remain at the survey station and conduct any desired broadcast surveys. Species-specific broadcast surveys are an optional part of this protocol and will likely be appropriate only in circumstances where there is particular interest in one or more very secretive species, or where it is important to achieve a nearly complete census for one or more species.

Vocalizations for a particular species should be broadcast only if the observer does not first detect the species within 50 m of the survey station during the preceding 7-minute point count. Broadcast the first species' vocalization for 15 seconds while slowly turning in a circle. Then wait 30 seconds and record data for any individuals of the target species that respond. Each individual that responds should be documented with its own line on the data form. Then repeat the 15-second broadcast and 30-second listening period for the same species. After recording the results for the second broadcast interval, begin the two broadcast and listening periods for the next species (if broadcasting for more than one species), until surveys are complete for each species. If broadcasting for multiple species, the order in which the species are surveyed should be randomized to eliminate order effects. An example of how the broadcast sequence might occur is as follows:

1. Complete point count survey at station "HL01".
2. Record the survey station number and the time in the first 2 columns of the broadcast survey
    a. 15 second species 1 broadcast; 30 second listening/observing.
    b. 15 second species 1 broadcast; 30 second listening/observing
    c. 15 second species 2 broadcast; 30 second listening/observing
    d. 15 second species 2 broadcast; 30 second listening/observing
    e. 15 second species 3 broadcast; 30 second listening/observing
    f. 15 second species 3 broadcast; 30 second listening/observing
3. Record any final comments and move to the next survey station to begin point count survey.

Required Equipment

- Binoculars
- Digital game caller or CD/MP3 player with speaker assembly
- CD or MP3 files of songs and calls of target species (unless using pre-programmed digital wildlife caller)
- Watch with stopwatch function
- Clipboard
- Data forms
- Maps and photos of site
- UTM coordinates of survey stations
- Pencils
- Field guide to western birds
- GPS unit
- Compass

- Rubber boots or waders (optional)

Completing the Broadcast survey form: field definitions and instructions

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary.
- **Meadow code** (not strictly necessary): Enter the 7-digit USGS quadrangle code plus a 3-digit sequential number designating whether it is the 1st, 2nd, 3rd, etc, meadow surveyed in this quadrangle (example: 39120D3_001).
- **Restoration/Reference**: Circle whether this meadow is a site where restoration is planned/has occurred, or a reference site.
- **UTM Northing**: Enter the 6-digit UTM northing coordinate (omit any preceding zeros).
- **UTM Easting:** Enter the 7-digit UTM easting coordinate (omit any preceding zeros).
- **Zone:** Enter the UTM zone in which the point location was collected and confirm that the GPS unit is recording coordinates in the NAD83 datum.
- **Survey Station code:** Enter the 4-character station code. When surveying stations that have been previously surveyed, be sure to use the already-established station code. When establishing new stations, the first two characters indicate the observers first and last initial. The last two characters indicate the sequential order of the point along the transect that parallels the primary channel (e.g. the first station surveyed upstream of the origination point would be 01; the second station would be 02, etc.). For each station you must write the station code the first row of data (describing the first bird detection) only. This space may be left blank for subsequent detections during the same broadcast survey.
- **Start time:** Record the 4-digit time of day the broadcast survey began (ex. 0620). For each station it is necessary to write the start time on the first row of data only (describing the first bird detection). This space may be left blank for subsequent detections during the same point count.
- **Species order:** In the heading, enter the 4-letter codes for any species you are targeting with broadcast surveys. Record a 1, 2, or 3 under the species codes provided to indicate the order in which species songs were broadcast.
- **Species:** If a target species is detected, enter the 4-letter bird species code.
- **Dist≤ 50m? (Y/N):** 'Y' indicates the bird was observed or detected within 50 m of you at the time it was first detected. 'N' indicates the bird was first detected at a distance greater than 50 m, even if it subsequently moves to a location within 50 m of you during the 7-minute point count.
- **Time interval:** Circle each broadcast time interval during which the individual bird was detected. For example, if the bird was only detected during the second broadcast interval, the "1" should be left uncircled and the "2" should be circled.
- **Detected before/after intervals (Y/_):** Record a Y if an individual of a target species is detected but the detection occurs either before that species' song is

broadcast, or after both broadcasts have occurred and you have moved on to another station). Otherwise, leave blank.

- **Ever sang (Y/N):** 'Y' indicates the bird sang at least once during the broadcast session, as opposed to identifying the bird based on its call or on a visual observation.
- **Comments:** Record comments about how individuals were identified and their location (distance and compass bearing). If desired, include GPS coordinates of responding birds, but collect them only after the broadcast is complete. For lengthy comments, write the comment on the back of the sheet, number it, and write the number in the comment field.

Avian Broadcast Survey Form

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Observer:_____ **Date:**_____/_____/_____

Forest/Park/County:_____ **Meadow name:**_____ **Restoration / Reference** (circle one)

Station No.	Start Time[1]	Species broadcast order[2]			Individuals detected[3]					Comment # (provide detailed comments on back)
		Sp. 1 _____	Sp. 2 _____	Sp. 3 _____	Species code	Dist <50m[4] (Y/N)	Time intervals[5]	Detected before/after intervals[6] (Y/_)	Ever sang?[7] (Y/_)	
							1 2			
							1 2			
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[1]Record time that first broadcast is started, regardless of species. Only complete for first row at the survey station even if multiple rows of data/individuals are detected. [2]Write a 1, 2, or 3 under the species codes indicating which species vocalization was broadcast 1st, 2nd, and 3rd. [3]Remaining columns require data be entered separately for each individual of a target species detected. [4] Mark a "Y" if the individual bird was ≤ 50m from the station at the time of first detection, "N" if >50m at time of first detection. [5]Circle each time interval that the bird was detected. [6]Mark a "Y" if the bird was detected but only before or after (not during) the broadcast survey at that station. [7]Mark a "Y" if the bird sang at any time during the broadcast intervals.

APPENDIX E

Conducting Area Searches

When all point count and broadcast surveys are complete, remain at the meadow site and begin the area search portion of the visit. The amount of time spent area searching is somewhat flexible, but should be influenced by the size of the meadow. We recommend spending at least 10 minutes area searching for every survey station the meadow accommodates. One of the objectives of the area search is to optimize the likelihood of detecting rarer or more secretive species that are present at the site, particularly species that may have been missed during the point count and broadcast portions of the survey. In general, the more time spent area searching, the greater the proportion of species present that will be detected. When conducting the area search, move through the site slowly and quietly, counting all birds detected at the site. Special attention should be paid to areas along stream channels or other flooded/ponded areas, and locations where restoration activities are planned. Additionally, areas of the meadow where sight and sound are obstructed by dense vegetation should be observed carefully. Although more time may be spent in these specific portions of the meadow, all areas and vegetation communities should be systematically covered.

All species and individuals should be recorded; however, special emphasis should be placed on obtaining an accurate count of any meadow-associated species identified as a "focal species" by the project manager and/or any species that is rare or otherwise of special concern. If a species of concern is detected during the area search, the location of individuals should be marked on a map or photo and/or GPS coordinates should be collected and recorded in the "comments" section of the form.

Tally individual birds on the form based on their location at the time of first detection, either within the meadow, or within the surrounding forest or other upland vegetation community. If the individual crosses between the meadow and surrounding habitats, tally the bird ONLY in the location where it was first detected. If an individual is detected along the margin between the two communities, assign it to one category. If a bird is in the herbaceous vegetation or riparian shrubs along the edge, count it as "Within Meadow". If a bird is utilizing upland shrubs or trees overhanging the meadow, count the individual as "Outside Meadow".

Required Equipment

- Binoculars
- Watch
- Clipboard
- Data forms
- Maps and photos of site
- Pencils
- Field guide to western birds
- GPS unit
- Compass
- Rubber boots or waders (optional)

Completing the area search form: field definitions and instructions

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary. For sites with long names we advise creating standardized 4 to 6 digit abbreviations prior to the field season. This practice will help to avoid subsequent confusion caused by multiple observers creating varying abbreviations (especially if multiple similarly named sites are being monitored).
- **Start time:** Record the time as hh:mm when the area search begins.
- **Stop time:** Record the time as hh:mm when the area search ends.

After completing the top portion of the form, record the following information for all species detected:

- **Species code:** For each species detected, record the 4 letter species code as provided in Appendix f.
- **Tally individuals**
    - **Within Meadow:** Record a tally mark in the field for each individual of the indicated species that was first detected in the meadow. Do not double count or erase and move the tally mark if the bird subsequently moves outside the meadow.
    - **Outside Meadow:** Record a tally mark in the field for each individual of the indicated species that was first detected outside of the meadow. Do not double count or erase and move the tally mark if the bird subsequently moves to an area within the meadow.
- **Total:** At the end of the area search, record the total number of individuals of the species detected.
- **Evidence of nesting**
    - **Carry**: Check the box if an adult of the species is seen carrying food, nesting material, or fecal sacs.
    - **Nest seen:** Check the box if a nest is seen and you are able to confirm which species built it (generally by observing parent in proximity (Note: do not risk disturbing the nest to approach closely or observe contents).
    - **Fledgl.**: Check the box if recently hatched fledglings or family groups are seen.
- **Comments:** For difficult-to-identify species record how individuals were identified. For rare or special interest species provide comments on where detections occurred or include GPS coordinates. For lengthy comments, write a number and provide the numbered comments on the back of the form.

Area Search Form

THE INSTITUTE FOR BIRD POPULATIONS

Observer:_____ **Date:_____/_____/_____**

Forest/Park/County_____ **Meadow Name:_____**

Start time___ ___:___ ___ **Stop time ___ ___ : ___ ___**

	Tally individuals[1]			Evidence of nesting [3] (check all that apply)			
Species Code	Within Meadow	Outside Meadow	Total[2]	Carry	Nest Seen	Fledgl.	Comments[4]

[1]Tally number individuals detected inside and outside the meadow (don't double count birds that cross the meadow edge). [2]Total number of individuals detected. [3]Check boxes if birds are seen carrying food, nesting material, fecal sacs, if recent fledglings/family groups are seen, or if nest is discovered. [4]For rare or difficult to ID species indicate how ID'd, and describe where detected.

APPENDIX F

Sierra Nevada Bird Species and their Codes

The following table (F-1) is a list of bird species that regularly occur within the Sierra Nevada range. The list is ordered by taxonomic group. This species list was generated by reviewing available range maps, data from the *Breeding Bird Survey* and the *Monitoring Avian Productivity and Survivorship* programs, and historical literature (Grinnell and Miller 1944, Orr and Moffitt 1971, and Gaines 1992), and also drew upon our collective experience working in Sierra Meadows over the last 20 years. Because species that are not necessarily meadow-associated can be detected during point counts and other monitoring activities we attempted to include all bird species regularly found in the Sierra Nevada and did not limit this list to meadow or riparian species. In addition to those species known to breed in the Sierra Nevada, we also included some migrant species that might be detected in meadows during the late spring and early summer period encompassed by this protocol. Nonetheless, it is not an exhaustive list and additional species may be detected, especially at the far northern and southern portions of the Sierra Nevada, and in the foothills. The primary purpose of this table is to provide the 4-letter species codes that are used on the forms included in the protocol.

Table F-1. Sierra Nevada bird species and their 4-character codes.

Species Code	***Common Name***	***Scientific Name***
CANG	Canada Goose	*Branta canadensis*
WODU	Wood Duck	*Aix sponsa*
GADW	Gadwall	*Anas strepera*
MALL	Mallard	*Anas platyrhynchos*
BWTE	Blue-winged Teal	*Anas discors*
CITE	Cinnamon Teal	*Anas cyanoptera*
NOPI	Northern Pintail	*Anas acuta*
GWTE	Green-winged Teal	*Anas crecca*
RNDU	Ring-necked Duck	*Aythya collaris*
BUFF	Bufflehead	*Bucephala albeola*
COME	Common Merganser	*Mergus merganser*
RUDU	Ruddy Duck	*Oxyura jamaicensis*
WTPT	White-tailed Ptarmigan	*Lagopus leucura*
SOGR	Sooty Grouse	*Dendragapus fuliginosus*
MOUQ	Mountain Quail	*Oreortyx pictus*
CAQU	California Quail	*Callipepla californica*
PBGR	Pied-billed Grebe	*Podilymbus podiceps*
EAGR	Eared Grebe	*Podiceps nigricollis*
WEGR	Western Grebe	*Aechmophorus occidentalis*
AWPE	American White Pelican	*Pelecanus erythrorhynchos*
AMBI	American Bittern	*Botaurus lentiginosus*
GBHE	Great Blue Heron	*Ardea herodias*
GREG	Great Egret	*Ardea alba*
GRHE	Green Heron	*Butorides virescens*
BCNH	Black-crowned Night-Heron	*Nycticorax nycticorax*
WFIB	White-faced Ibis	*Plegadis chihi*

Species Code	***Common Name***	***Scientific Name***
TUVU	Turkey Vulture	*Cathartes aura*
OSPR	Osprey	*Pandion haliaetus*
WTKI	White-tailed Kite	*Elanus leucurus*
BAEA	Bald Eagle	*Haliaeetus leucocephalus*
NOHA	Northern Harrier	*Circus cyaneus*
SSHA	Sharp-shinned Hawk	*Accipiter striatus*
COHA	Cooper's Hawk	*Accipiter cooperii*
NOGO	Northern Goshawk	*Accipiter gentilis*
RSHA	Red-shouldered Hawk	*Buteo lineatus*
SWHA	Swainson's Hawk	*Buteo swainsoni*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
GOEA	Golden Eagle	*Aquila chrysaetos*
AMKE	American Kestrel	*Falco sparverius*
PEFA	Peregrine Falcon	*Falco peregrinus*
PRFA	Prairie Falcon	*Falco mexicanus*
YERA	Yellow Rail	*Coturnicops noveboracensis*
BLRA	Black Rail	*Laterallus jamaicensis*
VIRA	Virginia Rail	*Rallus limicola*
SORA	Sora	*Porzana carolina*
AMCO	American Coot	*Fulica americana*
SACR	Sandhill Crane	*Grus canadensis*
KILL	Killdeer	*Charadrius vociferus*
SPSA	Spotted Sandpiper	*Actitis macularius*
LBCU	Long-billed Curlew	*Numenius americanus*
WISN	Wilson's Snipe	*Gallinago delicata*
WIPH	Wilson's Phalarope	*Phalaropus tricolor*
CAGU	California Gull	*Larus californicus*
CATE	Caspian Tern	*Hydroprogne caspia*
BLTE	Black Tern	*Chlidonias niger*
FOTE	Forster's Tern	*Sterna forsteri*
ROPI	Rock Pigeon	*Columba livia*
BTPI	Band-tailed Pigeon	*Patagioenas fasciata*
MODO	Mourning Dove	*Zenaida macroura*
GRRO	Greater Roadrunner	*Geococcyx californianus*
BANO	Barn Owl	*Tyto alba*
FLOW	Flammulated Owl	*Otus flammeolus*
WESO	Western Screech-Owl	*Megascops kennicottii*
GHOW	Great Horned Owl	*Bubo virginianus*
NOPO	Northern Pygmy-Owl	*Glaucidium gnoma*
SPOW	Spotted Owl	*Strix occidentalis*
GGOW	Great Gray Owl	*Strix nebulosa*
LEOW	Long-eared Owl	*Asio otus*
SEOW	Short-eared Owl	*Asio flammeus*
NSWO	Northern Saw-whet Owl	*Aegolius acadicus*
CONI	Common Nighthawk	*Chordeiles minor*
COPO	Common Poorwill	*Phalaenoptilus nuttallii*
BLSW	Black Swift	*Cypseloides niger*
VASW	Vaux's Swift	*Chaetura vauxi*
WTSW	White-throated Swift	*Aeronautes saxatalis*
BCHU	Black-chinned Hummingbird	*Archilochus alexandri*
ANHU	Anna's Hummingbird	*Calypte anna*
CAHU	Calliope Hummingbird	*Stellula calliope*

Species Code	***Common Name***	***Scientific Name***
RUHU	Rufous Hummingbird	*Selasphorus rufus*
BEKI	Belted Kingfisher	*Ceryle alcyon*
ACWO	Acorn Woodpecker	*Melanerpes formicivorus*
WISA	Williamson's Sapsucker	*Sphyrapicus thyroideus*
RBSA	Red-breasted Sapsucker	*Sphyrapicus ruber*
NUWO	Nuttall's Woodpecker	*Picoides nuttallii*
DOWO	Downy Woodpecker	*Picoides pubescens*
HAWO	Hairy Woodpecker	*Picoides villosus*
WHWO	White-headed Woodpecker	*Picoides albolarvatus*
BBWO	Black-backed Woodpecker	*Picoides arcticus*
NOFL	Northern Flicker	*Colaptes auratus*
PIWO	Pileated Woodpecker	*Dryocopus pileatus*
OSFL	Olive-sided Flycatcher	*Contopus cooperi*
WEWP	Western Wood-Pewee	*Contopus sordidulus*
WIFL	Willow Flycatcher	*Empidonax traillii*
HAFL	Hammond's Flycatcher	*Empidonax hammondii*
GRFL	Gray Flycatcher	*Empidonax wrightii*
DUFL	Dusky Flycatcher	*Empidonax oberholseri*
PSFL	Pacific-slope Flycatcher	*Empidonax difficilis*
BLPH	Black Phoebe	*Sayornis nigricans*
ATFL	Ash-throated Flycatcher	*Myiarchus cinerascens*
WEKI	Western Kingbird	*Tyrannus verticalis*
LOSH	Loggerhead Shrike	*Lanius ludovicianus*
CAVI	Cassin's Vireo	*Vireo cassinii*
HUVI	Hutton's Vireo	*Vireo huttoni*
WAVI	Warbling Vireo	*Vireo gilvus*
STJA	Steller's Jay	*Cyanocitta stelleri*
WESJ	Western Scrub-Jay	*Aphelocoma californica*
PIJA	Pinyon Jay	*Gymnorhinus cyanocephalus*
CLNU	Clark's Nutcracker	*Nucifraga columbiana*
AMCR	American Crow	*Corvus brachyrhynchos*
CORA	Common Raven	*Corvus corax*
HOLA	Horned Lark	*Eremophila alpestris*
PUMA	Purple Martin	*Progne subis*
TRES	Tree Swallow	*Tachycineta bicolor*
VGSW	Violet-green Swallow	*Tachycineta thalassina*
NRWS	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
CLSW	Cliff Swallow	*Petrochelidon pyrrhonota*
BARS	Barn Swallow	*Hirundo rustica*
MOCH	Mountain Chickadee	*Poecile gambeli*
CBCH	Chestnut-backed Chickadee	*Poecile rufescens*
OATI	Oak Titmouse	*Baeolophus inornatus*
BUSH	Bushtit	*Psaltriparus minimus*
RBNU	Red-breasted Nuthatch	*Sitta canadensis*
WBNU	White-breasted Nuthatch	*Sitta carolinensis*
PYNU	Pygmy Nuthatch	*Sitta pygmaea*
BRCR	Brown Creeper	*Certhia americana*
ROWR	Rock Wren	*Salpinctes obsoletus*
CANW	Canyon Wren	*Catherpes mexicanus*
BEWR	Bewick's Wren	*Thryomanes bewickii*
HOWR	House Wren	*Troglodytes aedon*
PAWR	Pacific Wren	*Troglodytes pacificus*

Species Code	***Common Name***	***Scientific Name***
MAWR	Marsh Wren	*Cistothorus palustris*
AMDI	American Dipper	*Cinclus mexicanus*
GCKI	Golden-crowned Kinglet	*Regulus satrapa*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
BGGN	Blue-gray Gnatcatcher	*Polioptila caerulea*
WEBL	Western Bluebird	*Sialia mexicana*
MOBL	Mountain Bluebird	*Sialia currucoides*
TOSO	Townsend's Solitaire	*Myadestes townsendi*
SWTH	Swainson's Thrush	*Catharus ustulatus*
HETH	Hermit Thrush	*Catharus guttatus*
AMRO	American Robin	*Turdus migratorius*
WREN	Wrentit	*Chamaea fasciata*
NOMO	Northern Mockingbird	*Mimus polyglottos*
CATH	California Thrasher	*Toxostoma redivivum*
EUST	European Starling	*Sturnus vulgaris*
AMPI	American Pipit	*Anthus rubescens*
CEDW	Cedar Waxwing	*Bombycilla cedrorum*
PHAI	Phainopepla	*Phainopepla nitens*
OCWA	Orange-crowned Warbler	*Vermivora celata*
NAWA	Nashville Warbler	*Vermivora ruficapilla*
YWAR	Yellow Warbler	*Dendroica petechia*
YRWA	Yellow-rumped Warbler	*Dendroica coronata*
BTYW	Black-throated Gray Warbler	*Dendroica nigrescens*
HEWA	Hermit Warbler	*Dendroica occidentalis*
MGWA	MacGillivray's Warbler	*Oporornis tolmiei*
COYE	Common Yellowthroat	*Geothlypis trichas*
WIWA	Wilson's Warbler	*Wilsonia pusilla*
YBCH	Yellow-breasted Chat	*Icteria virens*
WETA	Western Tanager	*Piranga ludoviciana*
GTTO	Green-tailed Towhee	*Pipilo chlorurus*
SPTO	Spotted Towhee	*Pipilo maculatus*
CALT	California Towhee	*Pipilo crissalis*
RCSP	Rufous-crowned Sparrow	*Aimophila ruficeps*
CHSP	Chipping Sparrow	*Spizella passerina*
BRSP	Brewer's Sparrow	*Spizella breweri*
BCSP	Black-chinned Sparrow	*Spizella atrogularis*
LASP	Lark Sparrow	*Chondestes grammacus*
BTSP	Black-throated Sparrow	*Amphispiza bilineata*
SAGS	Sage Sparrow	*Amphispiza belli*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
GRSP	Grasshopper Sparrow	*Ammodramus savannarum*
FOSP	Fox Sparrow	*Passerella iliaca*
SOSP	Song Sparrow	*Melospiza melodia*
LISP	Lincoln's Sparrow	*Melospiza lincolnii*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
DEJU	Dark-eyed Junco	*Junco hyemalis*
BHGR	Black-headed Grosbeak	*Pheucticus melanocephalus*
BLGR	Blue Grosbeak	*Passerina caerulea*
LAZB	Lazuli Bunting	*Passerina amoena*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
WEME	Western Meadowlark	*Sturnella neglecta*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*

Species Code	***Common Name***	***Scientific Name***
BHCO	Brown-headed Cowbird	*Molothrus ater*
BUOR	Bullock's Oriole	*Icterus bullockii*
GCRF	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
PIGR	Pine Grosbeak	*Pinicola enucleator*
PUFI	Purple Finch	*Carpodacus purpureus*
CAFI	Cassin's Finch	*Carpodacus cassinii*
HOFI	House Finch	*Carpodacus mexicanus*
RECR	Red Crossbill	*Loxia curvirostra*
PISI	Pine Siskin	*Carduelis pinus*
LEGO	Lesser Goldfinch	*Carduelis psaltria*
LAGO	Lawrence's Goldfinch	*Carduelis lawrencei*
AMGO	American Goldfinch	*Carduelis tristis*
EVGR	Evening Grosbeak	*Coccothraustes vespertinus*
HOSP	House Sparrow	*Passer domesticus*

APPENDIX G

Assessing Vegetation

This protocol assesses the vegetative structure and vegetative community types at each survey station using ocular estimates. During the first site visit, if riparian shrubs are not yet leafed out, or herbaceous vegetation is only beginning to appear, then the collection of vegetation data should be postponed until the second visit. We recommend that vegetation data are collected on the same day as one of the bird surveys, but this is not strictly necessary. These data should be collected after the day's bird surveys have been completed. We recommend allowing approximately 20 min for completion of the *meadow vegetation structure and cover form* at each count station. The actual amount of time will vary depending on the structural complexity of the vegetation at the site, difficulty moving within the plot and the experience of the field technician. Training will help streamline data collection, maximize consistency between technicians, and greatly improve the accuracy of ocular estimates of cover. Familiarity with riparian versus upland shrubs and age classes of tree and shrub species will also improve results and efficiency. In some instances, vegetation plots may extend into the surrounding forest or other upland community. These areas should be included in cover estimates. For example, if herbaceous vegetation only occurs in the meadow portion of the quadrant and only 50% of the quadrant is in the meadow community, then the herbaceous component cannot be more than 50% cover, even if herbaceous cover within the meadow community is 100%.

The *Meadow Vegetation Structure & Cover Form* records percent cover of vegetative components, as well as surface water cover within a 50-m radius circular plot centered on the survey station (Fig G-1). The circular plot is divided into four quadrants (NW, NE, SE, SW) by four 50-m transects that extend from the survey station in each of the cardinal directions (N, S, E, W). We recommend placing a vinyl pin flag at the center of the vegetation plot (at the survey station) and then using a compass with the declination set at zero (true north), or a GPS unit, to set up the plot. At each station measure out to 50 m in each of the cardinal directions, using pacing, a 50-m tape, or GPS unit, and place another pin flag. Once these flags are in place, record cover values for each vegetation type after first walking the quadrant to observe the entire area. Cover is estimated as if one is looking down on the site from above. Totals of all cover types combined may equal more than 100% because values will be summed over multiple levels of the canopy: herbaceous, shrub, tree. Once vegetation estimates are complete, pin flags should be removed from the site.

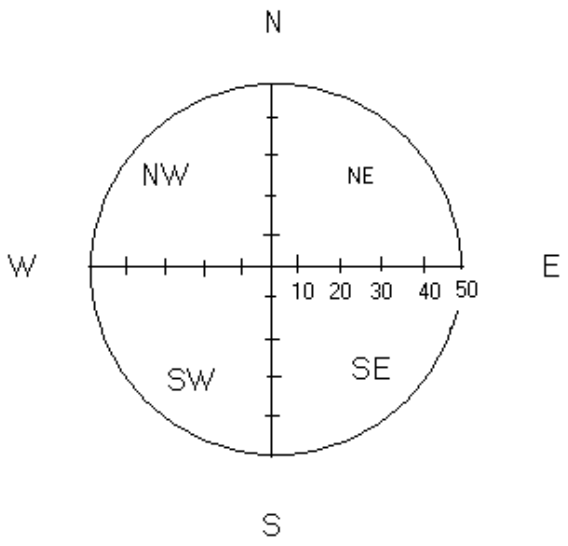


Figure G-1. A 50-m radius vegetation plot centered on the survey station and depicting the four quadrants (NW, SW, SE, and NE) used for the meadow vegetation structure and percent cover classifications.

Required Equipment:

- GPS unit to find plot
- 50-m tape or practiced pacing for defining quadrants
- Compass
- Clipboard
- Forms
- Pencil
- Permanent marker
- Flagging or pin flags
- Rubber boots or waders (optional)

Completing the Meadow Vegetation Structure & Cover Form: field definitions and instructions

- **Observer:** Enter the first and last name of the observer.
- **Date:** Enter the date as mm/dd/yyyy.
- **Park/Forest/County:** Enter the name of the national forest, national park or county – whichever is most useful.
- **Meadow name:** Enter the name of the meadow as it appears on the map. For unnamed meadows use the name of the stream that flows through the meadow, or the closest named stream to which it is a tributary.
- **Survey Station Number**: Enter the 4 digit alpha-numeric code of the point count station/vegetation plot.

The remaining data fields will be filled out for each of the four quadrants bounded by the N, S, E, and W bearings centered on the survey station and extending 50m.

Percent Cover by Vegetation and Surface Water: Vegetation and surface water data is recorded for each quadrant to the nearest 1%. Total cover when all classes are added may be greater than 100% because of overlapping herbaceous, understory, and overstory vegetation layers.

Riparian Shrub Height classes by Quadrant: Percent cover of riparian shrubs within each quadrant is described by height/age class. The total percent of all combined should equal 100%. If no riparian shrubs occur in the quadrant then leave the field blank.

<1m s = shrubs < 1m in height (seedling/sapling, stems usually < 1cm diameter at base; with little or on branching)
<1m = shrubs < 1m in height (mature)
1-2m = shrubs 1-2 in height (mature)
>2m = shrubs > 2 m in height (mature)

Riparian Shrub Type by Quadrant: Percent cover of riparian shrubs within each quadrant is described by taxonomic group. The total percent of all combined should equal 100%. If no riparian shrubs occur in the quadrant then leave the field blank. Riparian deciduous shrubs include willows (*Salix* spp), mountain alder (*Alnus tenufolia*), creek dogwood (*Cornus* spp), twinberry (*Lonicera* spp) and others. Non-riparian shrubs that should NOT be recorded are upland associated chapparal species including sagebrush species (*Artemisia* spp), bitterbrush (*Pershia tridentata*), Chemise (*Adenostoma fasciculatum*), and *Manzanita* spp., etc.

Tree Type by Quadrant: Percent cover of trees within each quadrant is described by taxonomic group and age class. The total percent of all combined should equal 100%. If no trees occur in the quadrant then leave the field blank.

% Conifer – mature = mature conifer (usually >4 m height, cone bearing)
% Conifer – immature = conifer seedling or sapling (≤4m height, not conebearing)
% Aspen – mature = mature aspen (usually >4 m height)
% Aspen – immature = aspen seedling/sapling (usually ≤ 4m height)
% Other Hardwood = other hardwood

Herbaceous Vegetation Type by Quadrant: Percent cover of 4 herbaceous (non-woody) vegetation types within each quadrant are estimated. The total percent of all combined should equal 100%. If no herbaceous vegetation occurs in the quadrant then leave the fields blank**.**

% grasslikes (grasses, sedges) = grasses, sedges and rushes, taxonomic groups that are "grasslike in appearance"
% small/medium forbs = "wildflowers" usually not growing to heights greater than 1/3 to ½ m in height
% large forbs (corn lily, cow parsnip, lupine etc) **=** "wildflowers" and other larger broadleaved flowering plants that typically grow quite large, greater than ½ m in height, and as tall as 2 m in some cases
% aquatic obligates (cattails, tules, etc) = Plants that only grow in perpetually wet situations and generally considered "marsh" plants

Meadow Vegetation Structure and Cover Form

Observer:_____ **Date:_____/_____/_____**

Forest/Park/County_____ Meadow Name:_____ Survey station #_____

Percent Cover by Vegetation and Surface Water

Cover Type	**Quadrant**			
	NE	SE	SW	NW
Tree				
Snag				
Downed log				
Riparian Shrub				
Sagebrush				
Non-woody vegetation				
Bare soil				
Leaf litter				
Gravel bar				
flowing water				
Standing water				

[1]Total of all cover types may be >100% when overstory, midstory and understory combined

The following tables break down cover of riparian shrub, tree, and herbaceous components by age, height, and taxonomy:

Riparian Shrub Height classes by Quadrant (must=100%)

	NE	SE	SW	NW
% < 1m (seedling/sapling)				
% < 1m (mature)				
% 1-2m				
% >2m				

Seedling/sapling have little or no branching and main stems are usually <1 cm at the base, mature shrubs have extensive branching regardless of height.

Riparian Shrub Type by Quadrant (must=100%)

	NE	SE	SW	NW
% Willow				
% Alder				
% Other Riparian Shrub __:_____				

Tree Type by Quadrant (must=100%)

	NE	SE	SW	NW
% Conifer – mature				
% Conifer - immature				
% Aspen – mature				
% Aspen – immature				
% Other Hardwood				

Immature: usually <4 m in height; Mature: usually ≥4 m in height.

Herbaceous (non-woody) Meadow Vegetation Type by Quadrant (must=100%)

	NE	SE	SW	NW
% grasslikes (grasses, sedges, juncus)				
% small/medium forbs (wildflowers)				
% large forbs (corn-lilly, cow parsnip, lupine etc)				
% aquatic obligates (cattails, tules, etc)				

APPENDIX H

Reporting Guidelines

Compiling and reporting results is a critical component of monitoring, and we strongly recommend producing a report – even a brief one – to tabulate and summarize results after each year that surveys are conducted. Here we provide some examples of metrics to report, and some templates for reporting them. However, appropriate analysis and reporting for a particular project may range from simply compiling a species list to sophisticated modeling efforts aimed at estimating detection probability and occupancy probability of target species. Here we provide templates for reporting basic survey results that can be adapted for project-level needs. Future versions of this protocol will provide guidance on assessing change over time in bird community composition and population-size indices at restoration sites.

Every report should provide summary information about the sites that were surveyed, who surveyed them, and the date of the surveys. Sample Table 1 provides a format for some of this information.

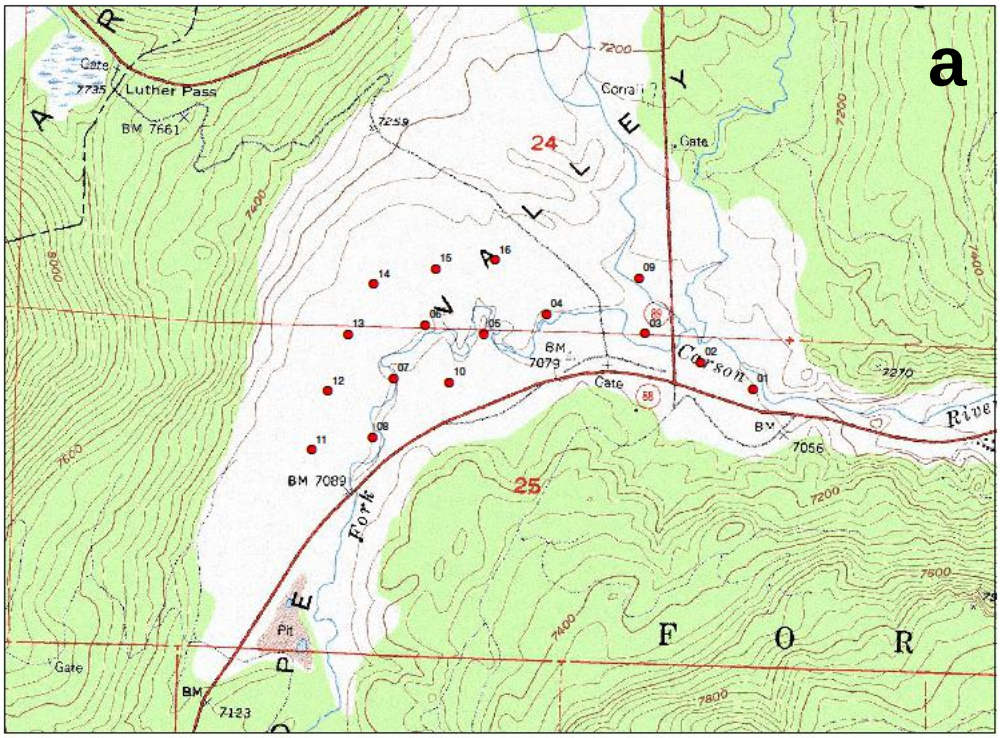
Sample Table 1. Study site location information and survey dates.

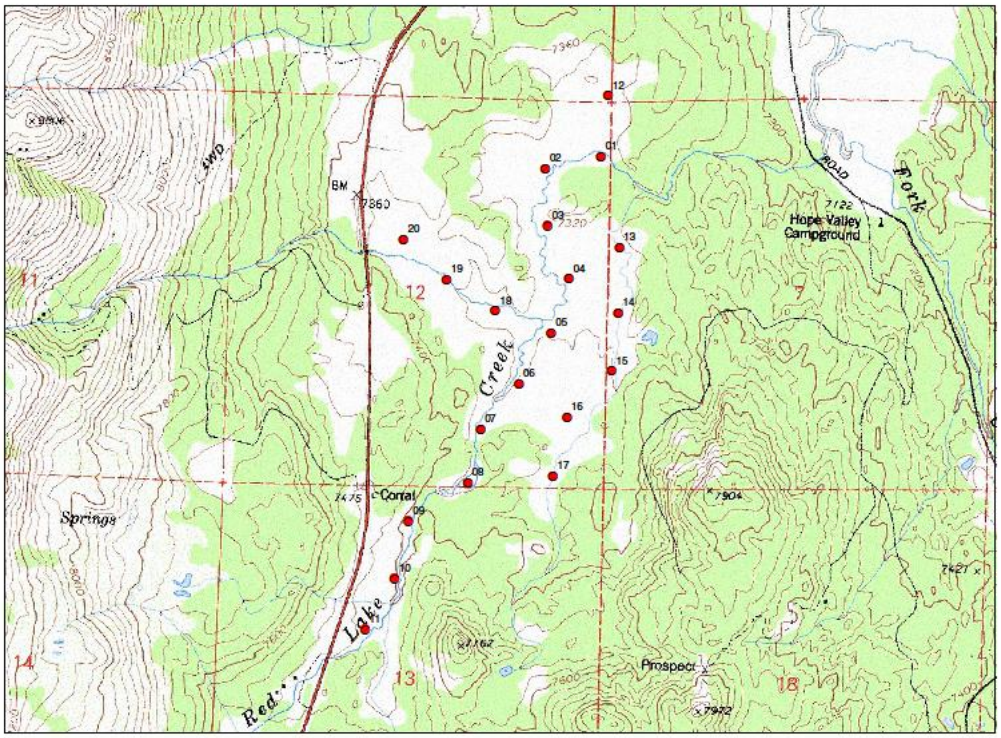
	Hope Valley Lower	***Red Lake Creek***
Site Type	Restoration	Reference
UTM Easting (NAD 83)[a]	245612	243908
UTM Northing (NAD 83)[a]	4296301	4290432
UTM Zone	11	11
Elevation	2134 m (7000')	2256 m (7400')
USGS Quadrangle	Freel Peak	Carson Pass
Visit 1 Date	5/29/2010	5/30/2010
Visit 2 Date	6/17/2010	6/11/2010
No. of Survey Stations	16	20

[a]Approximate center of meadow or project area.

Reports should also indicate the precise location of individual survey stations, in a map if possible (Sample Figure 1), and also in tabular form (Sample Table 2) or by referencing an archived project database.

Sample Figure 1. Locations of point count survey stations (numbered red circles) at a) Hope Valley Lower meadow and b) Red Lake Creek meadow.





Sample Table 2. Geographic coordinates of survey station locations.

Site Name	***Station Number***	***UTM Zone***	***UTM Easting[a]***	***UTM Northing[a]***
Hope Valley Lower	01	11	246759	4295979
Hope Valley Lower	02	11	246539	4296092
Hope Valley Lower	03	11	246304	4296214
Hope Valley Lower	04	11	245888	4296297
Hope Valley Lower	05	11	245625	4296213
Hope Valley Lower	06	11	245376	4296252
Hope Valley Lower	07	11	245241	4296025
Hope Valley Lower	08	11	245153	4295778
Hope Valley Lower	09	11	246278	4296447
Hope Valley Lower	10	11	245478	4296008
Hope Valley Lower	11	11	244896	4295723
Hope Valley Lower	12	11	244964	4295971
Hope Valley Lower	13	11	245050	4296211
Hope Valley Lower	14	11	245158	4296424
Hope Valley Lower	15	11	245420	4296489
Hope Valley Lower	16	11	245670	4296526
Red Lake Creek	01	11	244176	4291190
Red Lake Creek	02	11	243940	4291138
Red Lake Creek	03	11	243950	4290897
Red Lake Creek	04	11	244040	4290672
Red Lake Creek	05	11	243965	4290443
Red Lake Creek	06	11	243829	4290229
Red Lake Creek	07	11	243667	4290038
Red Lake Creek	08	11	243613	4289812
Red Lake Creek	09	11	243362	4289650
Red Lake Creek	10	11	243303	4289407
Red Lake Creek	11	11	243179	4289192
Red Lake Creek	12	11	244206	4291446
Red Lake Creek	13	11	244253	4290804
Red Lake Creek	14	11	244248	4290529
Red Lake Creek	15	11	244221	4290283
Red Lake Creek	16	11	244032	4290088
Red Lake Creek	17	11	243972	4289840
Red Lake Creek	18	11	243729	4290537
Red Lake Creek	19	11	243524	4290671
Red Lake Creek	20	11	243341	4290839

[a]All coordinates are in NAD 83

Bird survey results should be reported in some detail. We suggest reporting quantitative results separately for point counts and area searches, and providing an overall list of all species detected using any survey methods. Sample tables for reporting these results (Sample Tables 3-7) are provided below.

Sample Table 3. Number of birds detected during point counts at Hope Valley Lower and Red Lake Creek. This table includes only a partial list of species detected, for illustration purposes.

	Hope Valley Lower (n = 16 survey stations)				***Red Lake Creek (n = 20 survey stations)***			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds Detected per Station[b]***		***Avg. No. of Birds Detected[a]***		***Avg. No. of Birds Detected per Station[b]***	
Species[c]	***<50m[d]***	***Unlimited Radius[e]***	***<50m[d]***	***Unlimited Radius[e]***	***<50m[d]***	***Unlimited Radius[e]***	***<50m[d]***	***Unlimited Radius[e]***
Canada Goose	0.00	0.00	0.00	0.00	0.00	5.50	0.00	0.28
Mallard	1.50	4.50	0.09	0.28	0.00	9.00	0.00	0.45
Sooty Grouse	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.05
Mountain Quail	0.00	2.50	0.00	0.16	0.00	1.50	0.00	0.08
California Quail	0.00	0.50	0.00	0.03	0.50	0.50	0.03	0.03
Great Blue Heron	0.00	0.50	0.00	0.03	0.00	0.00	0.00	0.00
Sora	**0.00**	**2.50**	**0.00**	**0.16**	**0.00**	**0.00**	**0.00**	**0.00**
Killdeer	1.50	6.50	0.09	0.41	1.00	6.50	0.05	0.33
Spotted Sandpiper	**3.50**	**13.50**	**0.22**	**0.84**	**6.50**	**15.50**	**0.33**	**0.78**
Wilson's Snipe	**0.50**	**8.00**	**0.03**	**0.50**	**0.00**	**3.50**	**0.00**	**0.18**
Red-breasted Sapsucker	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.50**	**0.00**	**0.08**
Hairy Woodpecker	0.00	0.00	0.00	0.00	0.50	0.50	0.03	0.03
Northern Flicker	0.00	4.50	0.00	0.28	0.00	5.00	0.00	0.25
Pileated Woodpecker	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.03
Olive-sided Flycatcher	0.00	0.50	0.00	0.03	0.00	0.00	0.00	0.00
Western Wood-Pewee	0.00	3.00	0.00	0.19	0.00	1.00	0.00	0.05
Hammond's Flycatcher	0.00	1.00	0.00	0.06	0.50	2.00	0.03	0.10
Dusky Flycatcher	0.50	2.50	0.03	0.16	0.50	5.00	0.03	0.25
Cassin's Vireo	0.00	1.00	0.00	0.06	0.00	0.50	0.00	0.03
Warbling Vireo	**0.00**	**1.00**	**0.00**	**0.06**	**0.50**	**1.00**	**0.03**	**0.05**
Steller's Jay	0.50	2.50	0.03	0.16	1.00	7.50	0.05	0.38

[a]Number of individual birds detected at the meadow, averaged across two survey visits.
[b]Number of individual birds detected divided by the number of survey stations and visits.
[c]Meadow focal species indicated in bold text.
[d]Only includes birds detected within 50m of a survey station.
[e]Includes all birds detected, regardless of distance from survey station.

Sample Table 4. Average number of individual birds and number of species detected during point count surveys.

Meadow Name	***No. of Survey Stations***	***Avg. No. Birds Detected[a]***		***Birds Detected Per Station[a]***		***Species Detected (Visits Pooled)***	
		<50m	***Unlimited Radius***	***<50m***	***Unlimited Radius***	***<50m***	***Unlimited Radius***
Hope Valley Lower	16	87	317.5	5.44	19.8	25	49
Red Lake Creek	20	131.5	398	6.58	19.9	34	57

[a]Number of birds detected and number of birds per station are reported as the mean value averaged across 2 visits.

Sample Table 5. Average number of birds detected during area searches at Hope Valley Lower (459 acres/186 hectares) and Red Lake Creek (283 acres/114 hectares). This table includes only a partial list of species detected, for illustration purposes.

	Avg. No. of Birds Detected					
	Hope Valley Lower			***Red Lake Creek***		
Species	***Meadow***	***Upland***	***Total***	***Meadow***	***Upland***	***Total***
Canada Goose	0.0	0.0	0.0	4.0	**0.0**	**4.0**
Mallard	6.0	0.0	6.0	0.0	0.0	0.0
Green-winged Teal	3.0	0.0	3.0	**1.0**	**0.0**	**1.0**
Common Merganser	3.0	0.0	3.0	0.0	0.0	0.0
Sooty Grouse	0.0	0.0	0.0	**0.0**	**1.0**	**1.0**
Mountain Quail	2.0	1.0	3.0	**0.0**	**2.0**	**2.0**
California Quail	3.0	0.5	3.5	**0.0**	**0.0**	**0.0**
Great Blue Heron	1.0	0.0	1.0	0.0	0.0	0.0
Red-tailed Hawk	**0.5**	**1.0**	**1.5**	**0.0**	**0.0**	**0.0**
Sora	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**
Killdeer	10.0	0.0	10.0	**3.5**	**0.0**	**3.5**
Spotted Sandpiper	**13.0**	**0.0**	**13.0**	**9.0**	**0.0**	**9.0**
Wilson's Snipe	**14.0**	**0.0**	**14.0**	**2.5**	**0.0**	**2.5**
Red-breasted Sapsucker	**0.0**	**0.0**	**0.0**	**0.0**	**1.0**	**1.0**
Hairy Woodpecker	0.0	1.0	1.0	0.0	0.0	0.0
Northern Flicker	1.5	2.5	4.0	0.0	0.0	0.0
Western Wood-Pewee	0.5	4.0	4.5	0.5	2.5	3.0
Hammond's Flycatcher	0.0	0.0	0.0	0.0	1.0	1.0
Dusky Flycatcher	1.0	2.0	3.0	2.0	4.5	6.5
Cassin's Vireo	0.0	0.0	0.0	0.0	2.0	0.0
Warbling Vireo	0.0	0.0	0.0	0.0	1.0	1.0
Steller's Jay	0.0	3.0	3.0	0.0	0.0	0.0
Clark's Nutcracker	0.5	3.0	3.5	0.0	5.0	5.0
Common Raven	2.0	0.0	2.0	1.0	0.0	1.0
Tree Swallow	2.0	0.0	2.0	5.0	0.0	5.0
Cliff Swallow	65.5	5.0	70.5	30.0	0.0	30.0
Mountain Chickadee	1.5	3.5	5.0	0.5	9.5	10.0
Red-breasted Nuthatch	0.0	1.0	1.0	0.0	4.0	0.0
House Wren	1.0	0.5	1.5	0.0	0.0	0.0
Mountain Bluebird	2.5	0.0	2.5	1.5	0.0	1.5
Townsend's Solitaire	0.0	0.0	0.0	0.0	3.0	3.0
American Robin	21.5	7.5	29.0	20.0	10.5	30.5
European Starling	6.0	1.0	7.0	0.0	0.0	0.0
Yellow Warbler	**8.0**	**0.0**	**8.0**	**0.0**	**0.0**	**0.0**
Yellow-rumped Warbler	0.0	2.0	2.0	0.0	4.0	4.0
Hermit Warbler	0.0	0.0	0.0	0.0	2.0	0.0
Wilson's Warbler	**2.0**	**0.0**	**2.0**	**1.0**	**0.0**	**1.0**
Western Tanager	0.0	0.0	0.0	0.0	2.0	2.0
Green-tailed Towhee	1.5	2.0	3.5	3.0	3.0	6.0
Spotted Towhee	1.0	0.0	1.0	0.0	0.0	0.0
California Towhee	2.0	0.0	2.0	0.0	0.0	0.0
Chipping Sparrow	0.0	0.0	0.0	1.5	0.5	2.0
Brewer's Sparrow	2.0	0.0	2.0	0.0	0.0	0.0
Vesper Sparrow	4.0	0.0	4.0	3.0	0.0	3.0
Savannah Sparrow	9.0	0.0	9.0	2.5	0.0	2.5
Song Sparrow	**20.0**	**0.0**	**20.0**	**4.0**	**0.0**	**4.0**
Lincoln's Sparrow	**3.5**	**0.5**	**4.0**	**3.5**	**0.0**	**3.5**
White-crowned Sparrow	**12.5**	**1.0**	**13.5**	**10.0**	**2.5**	**12.5**
Dark-eyed Junco	2.0	1.5	3.5	2.5	8.5	11.0

Sample Table 6. Number of species detected with area search and point count surveys. Results are pooled across both visits to each meadow.

Meadow Name	***No. of Species Detected - Area Searches***	***No. of Species Detected - Point Counts***	***No. of Species Detected Only During Area Searches***	***No. of Species Detected - Both Methods***
Hope Valley Lower	49	44	7	56
Red Lake Creek	57	41	2	59

Sample Table 7. All bird species detected during point counts or area searches at each meadow. This table includes only a partial list of species detected, for illustration purposes.

Species[a]	***Hope Valley Lower***	***Red Lake Creek***
Canada Goose		X
Mallard	X	X
Green-winged Teal	X	X
Common Merganser	X	
Sooty Grouse		X
Mountain Quail	X	X
California Quail	X	X
Great Blue Heron	X	
Osprey		X
Bald Eagle	X	X
Red-tailed Hawk	X	X
Sora	**X**	
Killdeer	X	X
Spotted Sandpiper	**X**	**X**
Wilson's Snipe	**X**	**X**
Red-breasted Sapsucker		**X**
Hairy Woodpecker	X	X
Northern Flicker	X	X
Pileated Woodpecker		X
Olive-sided Flycatcher	X	
Western Wood-Pewee	X	X
Hammond's Flycatcher	X	X
Dusky Flycatcher	X	X
Cassin's Vireo	X	X
Warbling Vireo	**X**	**X**
Steller's Jay	X	X
Clark's Nutcracker	X	X
Common Raven	X	X
Tree Swallow	X	X
Cliff Swallow	X	X
Barn Swallow		X
Mountain Chickadee	X	X
Red-breasted Nuthatch	X	X
Pygmy Nuthatch		X
House Wren	X	X
Golden-crowned Kinglet		X
Ruby-crowned Kinglet		X
Blue-gray Gnatcatcher	X	
Western Bluebird	X	
Mountain Bluebird	X	X
Townsend's Solitaire		X

If vegetation data are collected at survey stations, those data too should be tabulated and summarized in the Annual Report. Here we provide two sample tables (Sample Tables 8 and 9) for summarizing information collected as part of the vegetation sampling component of this protocol.

Sample Table 8. Average vegetative and water cover characteristics for 50-m plots surrounding survey stations at each meadow.

	Mean Percent Cover (SE)	
Cover class	***Hope Valley Lower***	***Red Lake Creek***
Trees	2.86 (1.42)	2.67 (1.30)
Snags	0.00 (0.00)	0.25 (0.10)
Riparian Shrubs	6.00 (2.68)	6.14 (2.95)
Sagebrush	7.34 (2.52)	2.64 (1.54)
Non-woody Vegetation	81.48 (5.32)	63.64 (9.43)
Bare Ground	2.70 (0.64)	6.43 (1.15)
Gravel Bar	1.44 (0.56)	0.62 (0.25)
Flowing Water	5.69 (2.12)	4.34 (1.05)
Standing Water	4.97 (1.80)	7.06 (4.06)

Sample Table 9. Average characteristics of riparian deciduous shrubs in 50-m plots surrounding survey stations.

	Percent of Shrubs	
Cover class	***Hope Valley Lower***	***Red Lake Creek***
Height and Age Class of Riparian Shrubs		
<1m (seedling)	3.36 (2.00)	0.12 (0.12)
<1m (mature)	15.76 (7.30)	12.41 (7.09)
1 - 2m	18.21 (4.82)	60.63 (9.92)
>2m	62.68 (8.55)	27.08 (8.00)
Taxonomic Composition of Riparian Shrubs		
Willow	96.50 (2.45)	90.91 (9.09)
Alder	0.00 (0.00)	9.09 (9.09)
Other Riparian Shrub	3.50 (2.45)	0.00 (0.00)