THE INSTITUTE FOR BIRD POPULATIONS

Pre-restoration bird surveys at meadows on the west slope of the Tahoe National Forest

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ABSTRACT

With funding from the National Fish and Wildlife Foundation in 2009-2010, The Institute for Bird Populations developed a monitoring protocol to assess how bird populations respond to meadow restoration activities in the Sierra Nevada. During summer 2010 we field-tested the protocol by conducting pre-restoration bird surveys at 28 meadows proposed for restoration and 32 reference meadows in the Sierra Nevada. Study sites were identified in collaboration with personnel at National Forests, National Parks, California State lands, and private landowners. Monitoring visits included point count surveys, broadcast surveys, area searches, and vegetation and soil moisture assessments. This report describes results of the pre-restoration monitoring completed at 8 meadows (4 intended restoration sites, and 4 paired reference sites) on the west slope of the Tahoe National Forest. We surveyed most meadows twice during the 2010 breeding season, conducting a total of 42 point count and broadcast surveys, and over 19 person-hours of area searching. Results of these surveys will provide baseline information for assessing the effects of future restoration activities on bird populations at each of the 4 intended restoration sites.

BACKGROUND

Montane meadows in the Sierra Nevada form ecological islands within the surrounding forest matrix (Ratliff 1985, Fites-Kaufman et al. 2007). 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 Moffit 1971, Gaines 1992, Graber 1996, Heath and Ballard 2003). However, at many Sierra meadows human activities and historic management practices 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, Kattlemann and Embury 1996, Cicero 1997, Siegel et al. 2008).

Throughout the Sierra Nevada, many public and private land managers are seeking win-win solutions for 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 assess the success of meadow restoration 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 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, Borgmann 2010).

Each of the meadow-associated 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). When meadow habitats are degraded the number of individual birds and the number of bird species occupying them tends to decline.

The primary objective of this project was to collect pre-restoration data on bird populations at meadows where future restoration projects are planned (and at associated reference sites). These data will allow assessment of the response of bird populations to future restoration activities. Such assessments are valuable both for documenting successes of restoration activities and for facilitating improvement of restoration techniques in an adaptive management context.

We used a draft bird survey protocol (Loffland et al. 2011) under development with funding from the National Fish and Wildlife Foundation designed specifically for pre- and post-restoration bird monitoring at meadow restoration sites. The protocol includes a combination of multi-species and single-species survey techniques, and incorporates point counts, species-specific broadcast surveys, area searches, and vegetation and soil moisture plots.

The use of a standardized survey protocol will help 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 allow future meadow restoration efforts to incorporate those findings.

METHODS

All of our methods adhered to Loffland et al.'s (2011) *Avian Monitoring Protocol for Sierra Nevada Meadows.* **Here we provide a cursory summary of methods, but readers seeking more detail or a discussion of the merits and limitations of particular methods should refer to the protocol itself.**

Monitoring Scheme

Loffland et al. (2011) suggest a BACI (Before, After, Control, Impact) monitoring scheme. Under this scheme all monitoring sites where restoration activities are planned are paired with one or more reference sites with similar hydrology and vegetation, but where no restoration activities are imminent. All monitoring activities are then conducted at both the restoration and reference sites in at least one year prior to restoration and at least 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 with the reference site 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).

Site Selection

During early spring of 2010 we met with USDA Forest Service Region 5 staff to discuss how best to identify meadow restoration projects in the planning stage on National Forest lands, and worked closely with the Regional Hydrologist as he queried forests in Region 5. We also consulted with personnel at Yosemite and Sequoia/Kings Canyon National Parks and state agencies, and private landowners. We placed a higher priority on restoration projects that were already in the planning stage, but also included some sites that were identified as needing restoration, but for which the NEPA/CEQA process had not yet begun. Following guidance from the National Fish and Wildlife Foundation, we made restoration projects with a hydrologic component our highest priority. The resulting set of 30 restoration projects was distributed across 6 National Forests, 2 National Parks, 2 California State Wildlife Areas, 1 California State Park, and 1 private parcel. After identifying the restoration projects, we worked with local contacts to identify suitable reference sites to pair with each restoration site. These collaborations yielded 32 reference sites (in 2 instances multiple small sites were paired with a single restoration site**). This report details the subset of our 2010 study sites that were located on the west slope of the Tahoe National Forest.**

Conversations with biologists and hydrologists on the west slope of the Tahoe National Forest identified 4 meadow restoration projects in various stages of planning. All restoration meadows described here have some restoration needs identified, but assessment and planning are in the early stages. For each restoration site we selected one or more reference sites based on advice of local experts and through the review of aerial photography (Table 1; Figure 1).

Table 1. Restoration and associated reference sites on the west slope of theTahoe National Forest where pre-restoration bird surveys were conducted during the 2010 breeding season.

Restoration Site	***Reference Site***
Butcher Ranch	Church Meadow West
Gold Valley[a]	Church Meadow East Bowl
Hawley Meadow[a]	Freeman Meadow
Loney Meadow	Austin Meadow

[a]Restoration sites not surveyed due to limited access during the 2010 breeding season.

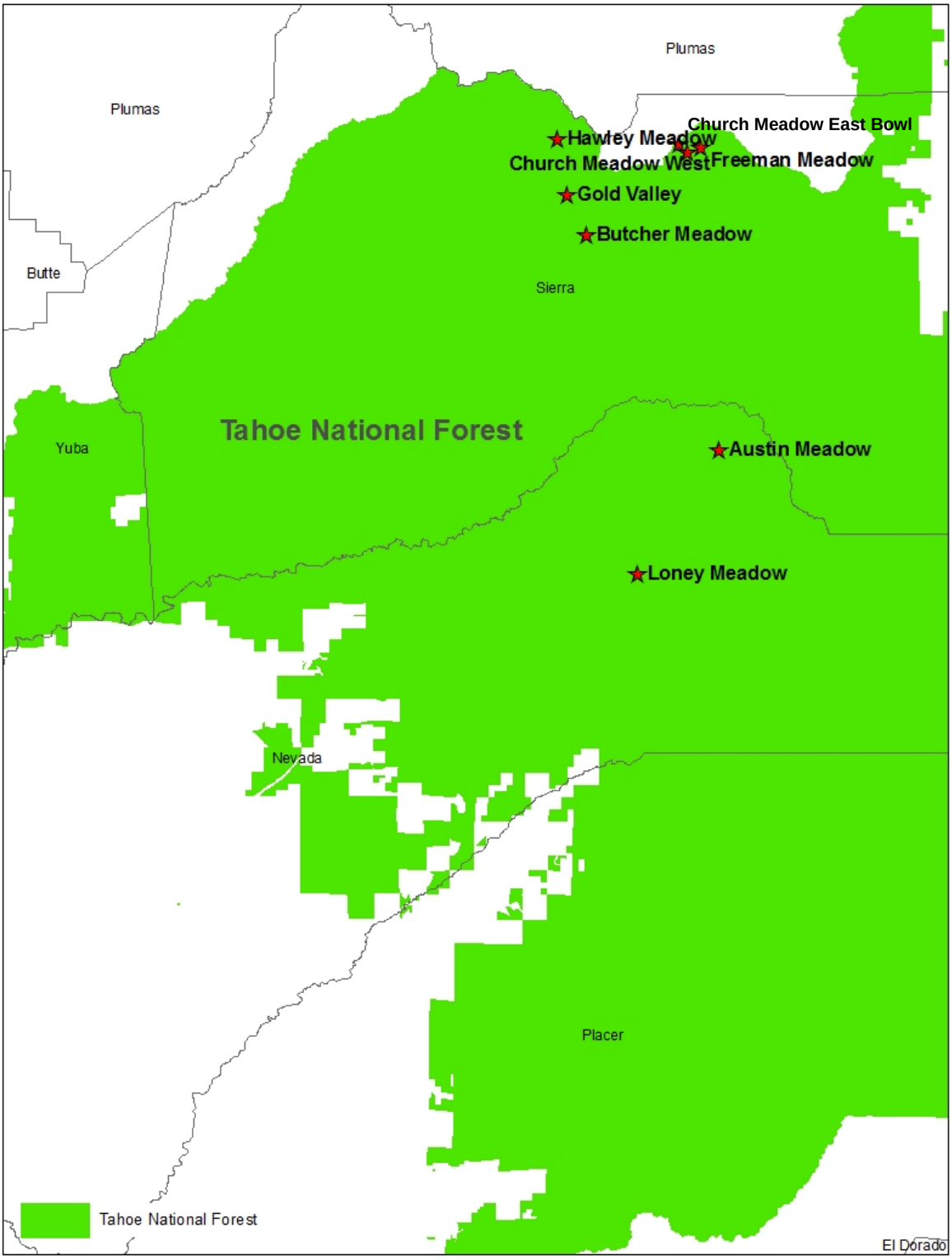

Figure 1. Locations of restoration and reference meadows surveyed for birds in 2010 on the west slope of the Tahoe National Forest.

Butcher Ranch, Gold Valley, and Hawley Meadow are all part of a larger restoration plan being developed for the Pauley Creek drainage in the North Fork Yuba River Watershed. These 3 sites occur at elevations between 5900 (1799 m) and 6675 ft (2035 m). Butcher Ranch and Hawley Meadow have relatively distinct meadow boundaries, but Gold Valley is an extensive series of "stringer" meadows occurring over many kilometers along Pauley Creek, and inter-mixed with conifer forest. The Pauley Creek sits within a steep region bounded by the Yuba River Canyon and the Sierra Butte formation, and as such suitable nearby reference meadows were difficult to locate. In addition, publicly owned large meadows on the west slope are relatively rare – sites like this were frequently not incorporated into national forests when their boundaries were delineated, but were instead retained in private land ownership as base ranches for grazing allotments (Allen-Diaz et al. 1999). To find suitable meadows for reference sites we opted to use meadows approximately 8 Km to the east on the other side of the Gold Lakes area at the Church and Freeman meadow systems. The 3 reference sites; Church Meadow West, Church Meadow East Bowl, and Freeman Meadow are part of a cluster of meadows that sit perched between the Feather and Yuba Drainages, just west of the Sierra Crest at 6800 ft. (2073 m).

We originally identified and mapped survey stations for the restoration sites at Gold Valley and Hawley Meadow, but due to heavy snows, these sites were not surveyed in 2010 (station locations are still included in Appendix A). Surveys were however conducted at their reference sites at Church Meadow East Bowl and Freeman Meadow. At this time we are treating these sites as additional reference sites for Butcher Ranch.

Loney Meadow occurs further south in the Bowman Lake region within the South Fork Yuba River watershed. This site has two distinct meadows with a forested riparian area connecting the two. A road crossing and stream incisement in the lower meadow are targeted for restoration. Nearby meadows with similar size, hydrology, geology, and vegetation were privately owned, so we selected Austin Meadow 10 Km to the northeast in the Middle Fork Yuba watershed.

All sites are surrounded by Sierra Mixed Conifer forest. Stands of Lodgepole Pine and occasionally Quaking Aspen are found along meadow edges. Many of these meadows are in areas with substantial granite outcrops occurring around the meadow edges, and dominating the upland areas.

Crew Training and Certification

All data were collected by full-time crew members working or volunteering for The Institute for Bird Populations. At the beginning of the 2010 field season, crew members underwent an intensive 3-week training session that followed the guidelines in Loffland et al. (2011) for ensuring surveyors are fully competent and qualified to collect reliable data. At the end of the training session all crew members passed a rigorous bird

identification exam that tested the skills necessary to conduct point counts and area searches.

Data Collection

All sites were surveyed within the May 20-July 15 temporal window specified by the Loffland et al. (2011) protocol; at most meadows we were able to complete two full surveys (excluding the vegetation and soil moisture plots which we only completed once, in accordance with the survey protocol).

Establishing Survey Stations

At restoration and reference meadows we established survey stations 250 m apart along transects that followed the general course of stream channels within meadows, as well as in areas of meadows with no adjacent stream. Where possible, survey stations were placed at least 25 m from streams that were large enough to cause substantial noise interference during surveys – this will also help ensure that if stream restoration results in inundation or widening of the channel, survey stations do not end up under water in future years. In narrow meadows (<100 m wide), stations were placed every 250 m along a transect that traveled along the center of the meadow, regardless of where the stream channel was located. In most cases survey stations were delineated prior to the first field visit using digital aerial photos (DOQQs) and ArcMap software. Geographic coordinates of individual survey stations are provided in Appendix A and site maps with survey station locations are provided in Appendix B. In a few instances stations were inaccessible due to the unusually high water conditions in June and July of 2010. For those stations that could not be reasonably relocated to a more accessible area nearby, surveys were not completed in 2010. Nonetheless, their coordinates remain in Appendix A, and the points should be surveyed if possible during future monitoring visits.

Point Counts

We utilized 10-minute point counts, divided into four smaller time intervals to facilitate estimating detection probability and modeling occupancy rates (MacKenzie et al. 2002) in the future, if desired. All birds were classified as being either $\leq$ 50 m from the survey station at first detection, or at a distance >50 m.

Species-Specific Broadcast Surveys

Immediately following each 10-min point count, we remained at the survey station and conducted broadcast surveys for 3 rare or hard to detect species that may be particularly likely to respond to meadow restoration efforts: Willow Flycatcher, Sora, and Virginia Rail. Vocalizations for a particular species were broadcast only if we did not first detect the species within 50 m of the survey station during the preceding 10-minute point count.

Area Searches

When all of the point count and broadcast surveys were completed, surveyors remained at the meadow and began the area search portion of the survey. The amount of time spent area searching was dependent on the size of the meadow; surveyors spent at least 10 minutes area-searching for every survey station the meadow accommodated. One of the objectives of the areas search was to increase the likelihood of detecting rarer or more secretive species that were present at the site, particularly species that may have been missed during the point count and broadcast portions of the survey. When conducting the area search, surveyors moved through the meadow slowly and quietly, counting all birds detected at the site. Special attention was paid to areas along stream channels or other flooded/ponded areas, and locations where restoration activities were planned. Additionally, areas of the meadow where sight and sound were obstructed by dense vegetation were observed carefully. Although more time may have been spent in these specific portions of the meadow, all areas and vegetation communities were systematically covered. We tallied individual birds based on their location at the time of first detection, either within the meadow, or within the surrounding forest or other upland vegetation community.

Vegetation and soil moisture plots

After completing bird surveys we assessed the vegetative structure and vegetative community types at each survey station to characterize the meadow and provide context for bird survey results. We recorded relative cover and vegetation height for a variety of vegetative and surface water components in each of the four quadrants formed by four 50-m transects extending away from the station in each of the cardinal directions (N, S, E, W). For each quadrant (NW, NE, SE, SW), we recorded cover for each vegetation type after first walking the quadrant to observe the entire area. Cover was estimated as if one was looking down on the site from above. Totals of all cover types combined sometimes exceeded 100% because values were combined over multiple overlapping levels of the canopy: herbaceous, shrub, and tree.

Data Analysis

Because only one year of baseline monitoring has been completed, the analysis reported here is relatively simple. From point count results at each meadow, we tabulated the number of species detected, the number of individuals of each species detected, and the number of individuals detected per point for all species combined. Results are provided separately for birds detected within 50 m of the survey station, and birds detected at any distance from the survey station. From area search results we provide numbers of individuals of each species, as well as the number of additional species detected that were not detected during point count surveys. We also tallied total number of individuals (of all species combined) counted and total number of species detected as the average across both visits (when two visits were completed). From broadcast surveys, we report the number, species and locations of any target species detected. Mean vegetation measurements are reported at the meadow scale, and are

intended to characterize the areas of the meadows where we conducted point counts and broadcast surveys.

RESULTS

During the late winter and early spring of 2010 the Sierra Nevada experienced heavier than average snowfall, and unusually late snowmelt. These conditions made planning and implementation of the monitoring work more difficult because many sites and access roads were under snow well into June and, in some cases, July. Many of our monitoring efforts had to be delayed until sites became accessible. Nonetheless, we were able to visit most sites at least once during our survey window of May 20 through July 15 (Table 2). Loffland et al. (2011) encourages two visits, but the second visit is considered optional. Hawley Meadow and Gold Valley remained inaccessible due to snow until well after the survey window was closed. As a result, these sites could not be surveyed in 2010. Similarly, Loney Meadow could only be visited one time. In total, 2 restoration sites, and 4 reference sites (6 total) within the west slope Tahoe N.F. region received at least one visit during 2010 breeding season. We surveyed 42 survey stations at the 6 study sites.

Table 2. Site location information and survey dates for meadows on the west slope of Tahoe National Forest.

Meadow Name[a]	***Site Type***	***UTM Easting***	***UTM Northing***	***UTM Zone***	***Elev. (ft)***	***USGS Quadrangle***	***Visit 1 Date***	***Visit 2 Date***	***No. of Survey Stations***
Butcher Ranch	**Restore**	**698172**	**4388314**	**10**	**6150**	**Sierra City**	**6/20/2010**	**7/10/2010**	**11**
Church Meadow West	Reference	704153	4394370	10	6800	Clio	6/20/2010	7/12/2010	8
Gold Valley	**Restore**	**696692**	**4392091**	**10**	**5900**	**Gold Lake**	**--**	**--**	**13**
Church Meadow East Bowl	Reference	704532	4394287	10	6800	Clio	6/20/2010	7/12/2010	6
Hawley Meadow	**Restore**	**695830**	**4394665**	**10**	**6675**	**Gold Lake**	**--**	**--**	**4**
Freeman Meadow	Reference	705108	4394492	10	6800	Clio	6/20/2010	7/12/2010	6
Loney Meadow	**Restore**	**701773**	**4313166**	**10**	**6000**	**Graniteville**	**7/9/2010**		**7**
Austin Meadow	Reference	707148	4374458	10	6770	English Mtn.	6/22/2010	7/9/2010	4

[a]Restoration sites are indicated in bold text with associated reference sites directly below them in plain text.

Point Counts

Among the meadows with survey results reported here, numbers of birds detected and number of species detected where similar across all sites (Table 3).

Table 3. Number of individual birds and number of species detected during point count surveys at all study sites.

Meadow Name[a]	*No. of Survey Stations*	*Avg. No. Birds Detected*[b]		*Avg. No. Birds Per Station*[b]		*Species Detected (Visits Pooled)*	
		<50m	*Unlimited Radius*	*<50m*	*Unlimited Radius*	*<50m*	*Unlimited Radius*
Butcher Ranch	**11**	**13.5**	**150.0**	**1.2**	**13.6**	**15**	**33**
Church Meadow West	8	30.5	119.5	3.8	14.9	19	29
Church Meadow East Bowl	6	21.0	97.5	3.5	16.3	14	31
Freeman Meadow	6	19.5	98.0	3.3	16.3	14	32
Loney Meadow	**7**	**16.0**	**122.0**	**2.3**	**17.4**	**7**	**31**
Austin Meadow	4	7.5	84.0	1.9	21.0	8	27

[a]Restoration sites are in bold text with associated reference sites directly below them in plain text.
[b]Values for numbers of birds and number of birds per stations are reported for individuals detected within a 50m radius of the survey station and for all individuals detected at all distances from the station (unlimited radius). Number of birds detected and number of birds per station are reported as the mean value averaged across 2 visits, except for sites where only one visit was completed.

Loffland et al. (2011) identify 18 meadow-associated focal species. These species were selected because of their affinity to meadow and riparian communities, and based on the expectation that their numbers would increase if meadow restoration efforts improved the quantity or quality of habitat components important to them. One exception is the Brown-headed Cowbird. While often found in meadows, this species also uses many other open or disturbed habitats with human or livestock use. Brown-headed Cowbirds were selected by Loffland et al. (2011) as focal species because of the role they play as nest parasites of other meadow-associated birds, and the association between their relative abundance and human disturbance. Of the 18 focal species identified for Sierra Nevada meadows, 11 were detected during point counts in the west slope Tahoe N.F. study region (Table 4).

The number of focal species detected at a given site ranged from a low of 6 at Freeman Meadow to a high of 10 at Church Meadow West. Of the focal species detected, Sandhill Crane was only detected at 1 site, while Warbling Vireo, Wilson's Warbler, and Lincoln's Sparrow were detected at all 6 meadows. Each of the remaining focal species was detected at 2 or more of the 6 meadows surveyed. The average number of individuals detected for each species, and the average number per survey station, are reported for all species at each restoration site and its associated reference site(s) in Appendix C.

Table 4. Relative abundance[a] of strongly meadow-associated focal bird species at each meadow. Focal species were identified by Loffland et al. (2011).

Meadow Name[b]	***Survey Radius***	***Sandhill Crane***	***Spotted Sandpiper***	***Red-breasted sapsucker***	***Warbling Vireo***	***Yellow Warbler***	***MacGillivray's Warbler***	***Wilson's Warbler***	***Song Sparrow***	***Lincoln's Sparrow***	***White-crowned Sparrow***	***Brown-headed cowbird***
Butcher Ranch	**≤50m**	**0.00**	**0.00**	**0.00**	**0.09**	**0.05**	**0.05**	**0.18**	**0.09**	**0.00**	**0.00**	**0.00**
	Unlim.	**0.00**	**0.05**	**0.00**	**1.00**	**0.36**	**0.27**	**1.05**	**0.50**	**0.55**	**0.00**	**0.18**
Church Meadow West	≤50m	0.00	0.00	0.06	0.44	0.06	0.00	0.13	0.06	0.44	0.44	0.00
	Unlim.	0.13	0.00	0.06	1.38	0.06	0.19	0.31	0.13	1.44	1.13	0.19
Church Meadow East Bowl	≤50m	0.00	0.00	0.00	0.00	0.00	0.08	0.25	0.00	0.58	0.42	0.00
	Unlim.	0.00	0.00	0.25	0.92	0.00	0.08	0.67	0.08	1.92	1.75	0.00
Freeman Meadow	≤50m	0.00	0.00	0.00	0.17	0.00	0.00	0.17	0.00	0.42	0.08	0.00
	Unlim.	0.00	0.00	0.17	0.75	0.00	0.17	0.50	0.00	1.42	0.83	0.00
Loney Meadow	**≤50m**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.14**	**0.00**	**0.29**
	Unlim.	**0.00**	**0.00**	**0.00**	**1.57**	**0.57**	**0.14**	**0.14**	**0.14**	**1.14**	**0.29**	**0.43**
Austin Meadow	≤50m	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.13	0.63	0.00
	Unlim.	0.00	0.63	0.00	1.38	0.25	0.00	1.38	0.00	1.63	0.88	0.13

[a]Number of individuals of each species divided by the number of visits and number of survey points, based on all detections within 50m of a survey point, and at unlimited distance. [b]Restoration sites are indicated with bold type.

Broadcast Surveys

Broadcast surveys for Sora, Virginia Rail, and Willow Flycatcher were completed at all survey stations. Vocalizations were only broadcast if the species was not spontaneously singing or calling within 50m of the survey station during the preceding point count. No target species were detected using broadcast surveys. Although Willow Flycatchers are known to have occupied Butcher Ranch in the recent past, they were not detected there, or at any other site within the west slope Tahoe N.F. region.

Area Searches

In most cases, we conducted area searches immediately following point count and broadcast surveys, but no later than 4.5 hours after sunrise. At large meadows, area searches were sometimes completed by a separate observer concurrent with point count surveys. In all but a few cases area searches were completed on the same morning as point counts. Area searches resulted in the mean detection of 4.0 (SD = 2.1) additional species per meadow in the west slope Tahoe N.F study region, over species totals based on point count surveys alone (Table 5). Species-specific area search results for each restoration site and its associated reference site are provided in Appendix D. Appendix E contains lists of all species detected (point counts and areas searches combined) at each meadow.

Table 5. Number of species detected using area search and point count results[a].

Meadow Name[b]	***No. Species Detected - Area Searches***	***No. Species Detected - Point Counts***	***No. Species Detected Only During Area Searches***	***No. Species - Both Methods Combined***
Austin Meadow	**33**	**27**	**6**	**33**
Butcher Ranch	**34**	**33**	**2**	**35**
Church Meadow East Bowl	34	31	5	36
Church Meadow West	33	29	6	35
Freeman Meadow	31	32	4	36
Loney Meadow	31	31	1	32

[a]Results are pooled across all visits. [b]Restoration sites indicated in bold text.

Vegetation Assessment

Vegetation and water measurements were collected at each survey station for the purpose of assessing the 50-m radius area surrounding each survey station, and to provide information characterizing the general vegetation communities and hydrologic conditions within the overall meadow. Table 6 provides the average cover values for each meadow, calculated from the means of the four quadrants at each survey station.

Tree and snag cover was greatest at linear stringer meadow sites where the forest edge regularly fell within 50 m of the survey stations or where trees were scattered in clumps within the meadow interior. Loney Meadow and Butcher Ranch had only 0.5% and 6.57% tree cover around survey stations, but the remaining meadows had values between 22% and 37%. Tree cover within the meadow can be an indicator of lowered water tables and conifer encroachment. Although meadow associated birds will utilize trees for foraging and territory advertisement, brown-headed cowbirds and nest predators also use trees within the meadow as hunting perches. Riparian shrub cover within the 50-m plots averaged 19.9 % (S.E. = 3.29), with the highest values at Butcher Ranch and Church Meadow East Bowl (24.05% and 30.75%, respectively). Extent of shrub cover is particularly important for many shrub-nesting bird species. . Sagebrush cover, often an indicator of lowered water tables, only occurred at Butcher Ranch (11%). Sagebrush is relatively rare on the west slope of the Sierra when compared with the east slope, so its value as an indicator of water table height is not as meaningful in this study region.

We quantified the amount of flowing and standing water around survey stations to assess habitat quality for bird species that are associated with water or saturated conditions. All sites had some surface water within the plots, but water cover from flowing or standing water did not exceed 15% at any site (Table 6).

Table 6. Average vegetative and water cover characteristics for 50-m plots surrounding survey stations at each meadow. Meadows not listed did not receive vegetation assessments.

Meadow Name[a]	*No. Stations*	*Measure[b]*	*Percent Cover*								
			Trees	*Snags*	*Riparian Shrubs*	*Sagebrush*	*Non-Woody Vegetation*	*Bare Ground*	*Gravel Bar*	*Flowing Water*	*Standing Water*
Butcher Ranch	**11**	**Mean**	**6.57**	**0.50**	**24.05**	**0.11**	**40.80**	**42.73**	**2.18**	**5.18**	**9.39**
		(S.E.)	**2.88**	**0.24**	**6.08**	**0.11**	**6.25**	**7.74**	**0.91**	**2.23**	**7.60**
Church Meadow West	8	Mean	30.72	0.53	15.38	0.00	71.34	9.56	0.78	6.72	14.47
		(S.E.)	9.66	0.26	5.36	0.00	6.20	5.15	0.40	0.93	3.83
Church Meadow East Bowl	6	Mean	22.17	0.00	30.75	0.00	46.42	24.42	0.83	10.75	3.21
		(S.E.)	10.33	0.00	8.58	0.00	12.90	6.46	0.83	2.07	1.19
Freeman Meadow	6	Mean	36.38	0.17	13.54	0.00	82.54	14.71	0.00	7.54	13.75
		(S.E.)	10.36	0.12	6.79	0.00	7.62	7.77	0.00	2.38	6.18
Loney Meadow	**6**	**Mean**	**0.50**	**0.08**	**14.21**	**0.00**	**94.50**	**2.96**	**0.00**	**2.13**	**3.50**
		(S.E.)	**0.32**	**0.08**	**10.98**	**0.00**	**1.52**	**1.12**	**0.00**	**0.70**	**0.77**
5 sites pooled	37	Mean	18.17	0.30	19.96	0.03	63.79	21.59	0.95	6.30	9.24
		(S.E.)	3.80	0.10	3.29	0.03	4.67	3.84	0.33	0.93	2.62

[a]Restoration sites indicated in bold text. [b]Mean and standard error averaged over four 50-m radius quadrants at each survey station.

For those survey stations with riparian deciduous shrub cover, we also assessed the proportion of the shrub component occurring within different height and age classes, as well as taxonomic group (Table 7). Immature shrubs in the lowest height class are indicative of shrub recruitment, an important factor in maintaining suitable habitat for shrub-nesting birds. Mature shrubs in the shortest height class can indicate certain low growing species, as well as situations where livestock or native ungulates are regulating growth patterns. These factors, as well as the proportion of the shrub community in the taller height classes, are relevant to certain focal bird species that prefer to nest at heights greater than 1 m above the ground. For all sites combined, the majority of riparian shrubs (59.97%) were > 2m tall, and Loney Meadow and Butcher Ranch had 68.63% and 77.13% of riparian shrub in this tallest height class, respectively. Only 1 site had more than 6% of shrubs in the seedling stage (Table 7). Willows were the dominant riparian shrub type at all sites.

Table 7. Average characteristics of riparian deciduous shrubs in 50-m plots surrounding survey stations. Study sites not listed had no riparian deciduous shrubs within survey plots.

			Height and Age Class of Riparian Shrubs (%)				***Taxonomic Composition of Riparian Shrubs***		
Meadow Name[a]	***No. Stations***	***Measure***[b]	***<1m (seedling)***	***<1m (mature)***	***1 - 2m***	***>2m***	***% Willow***	***% Alder***	***% Other Riparian Shrub***
Butcher Ranch	**10**	**Mean**	**0.00**	**3.25**	**19.63**	**77.13**	**49.75**	**42.25**	**8.00**
		(S.E.)	**0.00**	**1.97**	**9.21**	**9.16**	**15.15**	**13.72**	**5.54**
Church Meadow West	7	Mean	5.18	3.57	33.10	58.51	100.00	0.00	0.00
		(S.E.)	2.19	1.35	9.80	12.02	0.00	0.00	0.00
Church Meadow East Bowl	6	Mean	2.71	3.54	39.17	54.58	84.17	15.83	0.00
		(S.E.)	1.78	2.38	14.07	13.23	10.10	10.10	0.00
Freeman Meadow	6	Mean	0.00	2.08	65.21	32.71	85.42	14.58	0.00
		(S.E.)	0.00	1.36	11.51	11.82	11.84	11.84	0.00
Loney Meadow	**4**	**Mean**	**21.25**	**0.63**	**9.50**	**68.63**	**40.00**	**10.00**	**50.00**
		(S.E.)	**21.25**	**0.63**	**4.09**	**23.26**	**24.17**	**9.19**	**28.87**

[a]Restoration sites are in bold text. [b]Mean and standard error averaged over four 50m-radius quadrants at each survey point

Discussion

We strongly recommend continuing bird monitoring activities at meadows in the west slope Tahoe N.F. region in as many pre- and post-restoration years as feasible. One way that we might alter monitoring methods from what was completed in 2010 would be to decrease the distance between survey stations to as little as 200 m if doing so would allow for the addition of even one more survey station at small meadows. Many of the meadows we visited in other regions in 2010 contained 3 or fewer survey stations. These small sample sizes can be problematic for some analyses, and if one or more stations can be added it could strengthen the monitoring results. Nevertheless we do not recommend altering station locations for the sites listed in this report where surveys occurred in 2010. Rather, any new reference or restoration sites that would contain 5 or fewer stations using 250-m spacing could benefit from maximizing the number of stations. We also assessed our 2010 results and decided that decreasing point count duration from 10 minutes to 7 minutes would provide reliable results while balancing the amount of time and effort necessary per point count. In addition, we did not find much benefit from species-specific broadcast surveys for Willow Flycatcher, Sora and Virginia Rail. Not surprisingly, these species were not often detected at sites in need of restoration, but even when detected there were only 3 instances during our surveys across the entire Sierra Nevada where broadcast surveys detected an individual that had not already been detected during point counts. While single-species broadcast surveys may still be useful for some projects, detection probabilities of Sora and Virginia Rail may be adequately high with passive survey methods that do not incorporate broadcasts, and Willow Flycatchers are likely to be surveyed with full-protocol surveys (Bombay et al. 2003) prior to restoration as part of the state and federal permitting processes.

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Appendix A. Geographic coordinates of survey station locations

Table A-1. Geographic coordinates of survey station locations[a].

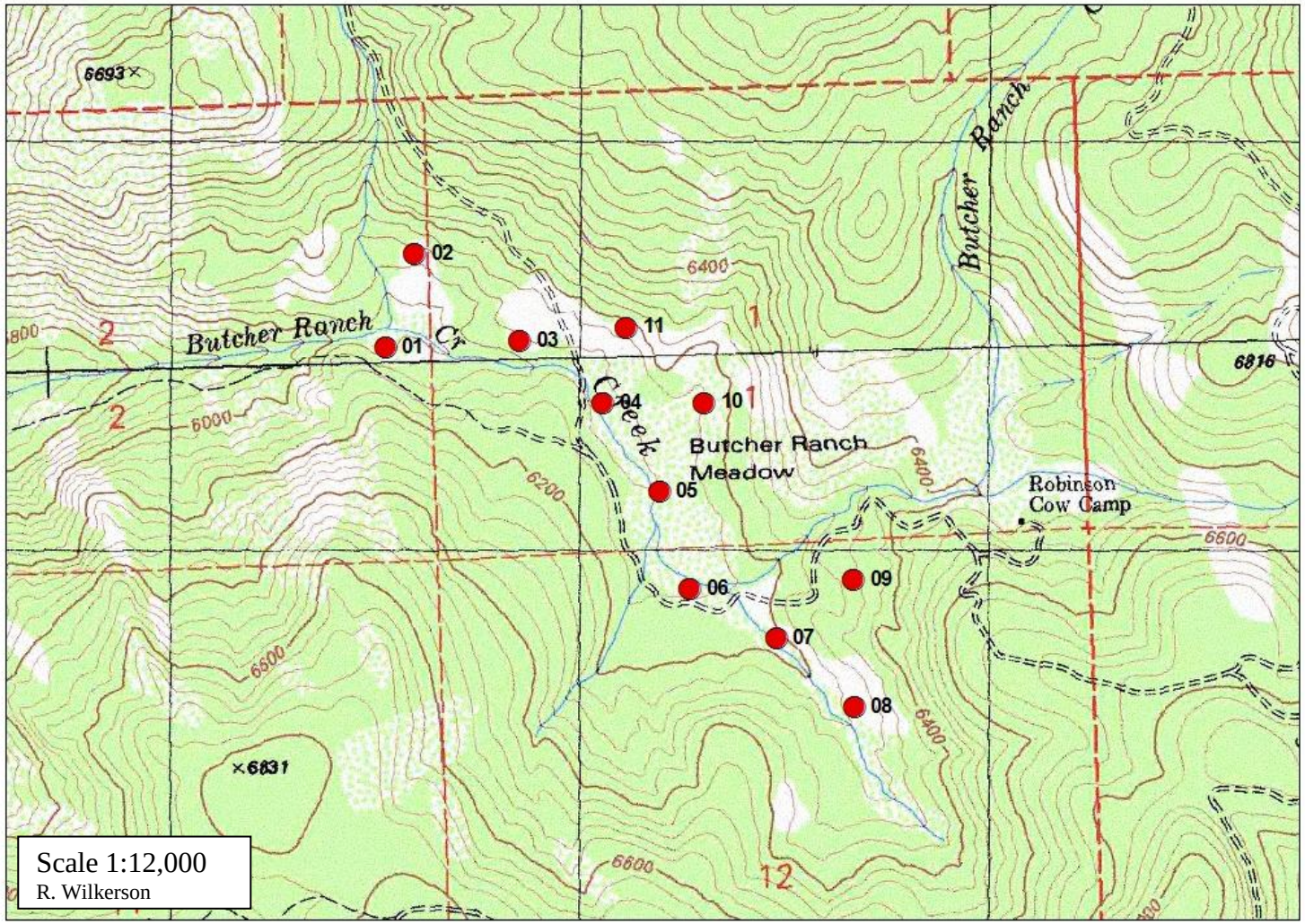
Meadow Name	*Station Number*	*UTM Zone*	*UTM Easting*	*UTM Northing*
Butcher Meadow	01	10	697429	4388696
Butcher Meadow	02	10	697500	4388922
Butcher Meadow	03	10	697757	4388711
Butcher Meadow	04	10	697961	4388558
Butcher Meadow	05	10	698098	4388344
Butcher Meadow	06	10	698173	4388105
Butcher Meadow	07	10	698384	4387984
Butcher Meadow	08	10	698574	4387817
Butcher Meadow	09	10	698573	4388128
Butcher Meadow	10	10	698208	4388560
Butcher Meadow	11	10	698017	4388744
Church Meadow West	01	10	703962	4393972
Church Meadow West	02	10	704082	4394185
Church Meadow West	03	10	704191	4394415
Church Meadow West	04	10	703999	4394553
Church Meadow West	05	10	704228	4394697
Church Meadow West	06	10	703807	4394373
Church Meadow West	07	10	703820	4394121
Church Meadow West	08	10	703714	4393899
Gold Valley	01	10	696590	4390501
Gold Valley	02	10	696552	4390752
Gold Valley	03	10	696425	4390969
Gold Valley	04	10	696719	4390939
Gold Valley	05	10	696403	4391707
Gold Valley	06	10	696259	4391914
Gold Valley	07	10	696678	4392068
Gold Valley	08	10	696532	4392275
Gold Valley	09	10	696559	4392487
Gold Valley	10	10	696337	4392590
Gold Valley	11	10	696116	4392821
Gold Valley	12	10	696308	4392927
Gold Valley	13	10	696075	4392572
Church Meadow East Bowl	01	10	704433	4394454
Church Meadow East Bowl	02	10	704544	4394222
Church Meadow East Bowl	03	10	704588	4393973
Church Meadow East Bowl	04	10	704598	4393724
Church Meadow East Bowl	05	10	704796	4393848
Church Meadow East Bowl	06	10	704539	4393478
Hawley Meadow	01	10	696119	4394459
Hawley Meadow	02	10	695927	4394588
Hawley Meadow	03	10	695691	4394614
Hawley Meadow	04	10	695839	4394772
Freeman Meadow	01	10	705028	4394534
Freeman Meadow	02	10	705279	4394546
Freeman Meadow	03	10	705458	4394366
Freeman Meadow	04	10	705613	4394544
Freeman Meadow	05	10	705545	4394112

Meadow Name	***Station Number***	***UTM Zone***	***UTM Easting***	***UTM Northing***
Freeman Meadow	06	10	705302	4394052
Loney Meadow	01	10	701696	4366130
Loney Meadow	02	10	701914	4366014
Loney Meadow	03	10	702150	4366109
Loney Meadow	04	10	701838	4366339
Loney Meadow	05	10	702597	4366226
Loney Meadow	06	10	702794	4366375
Loney Meadow	07	10	702845	4366174
Austin Meadow	01	10	706843	4374254
Austin Meadow	02	10	707046	4374381
Austin Meadow	03	10	707277	4374489
Austin Meadow	04	10	707536	4374524

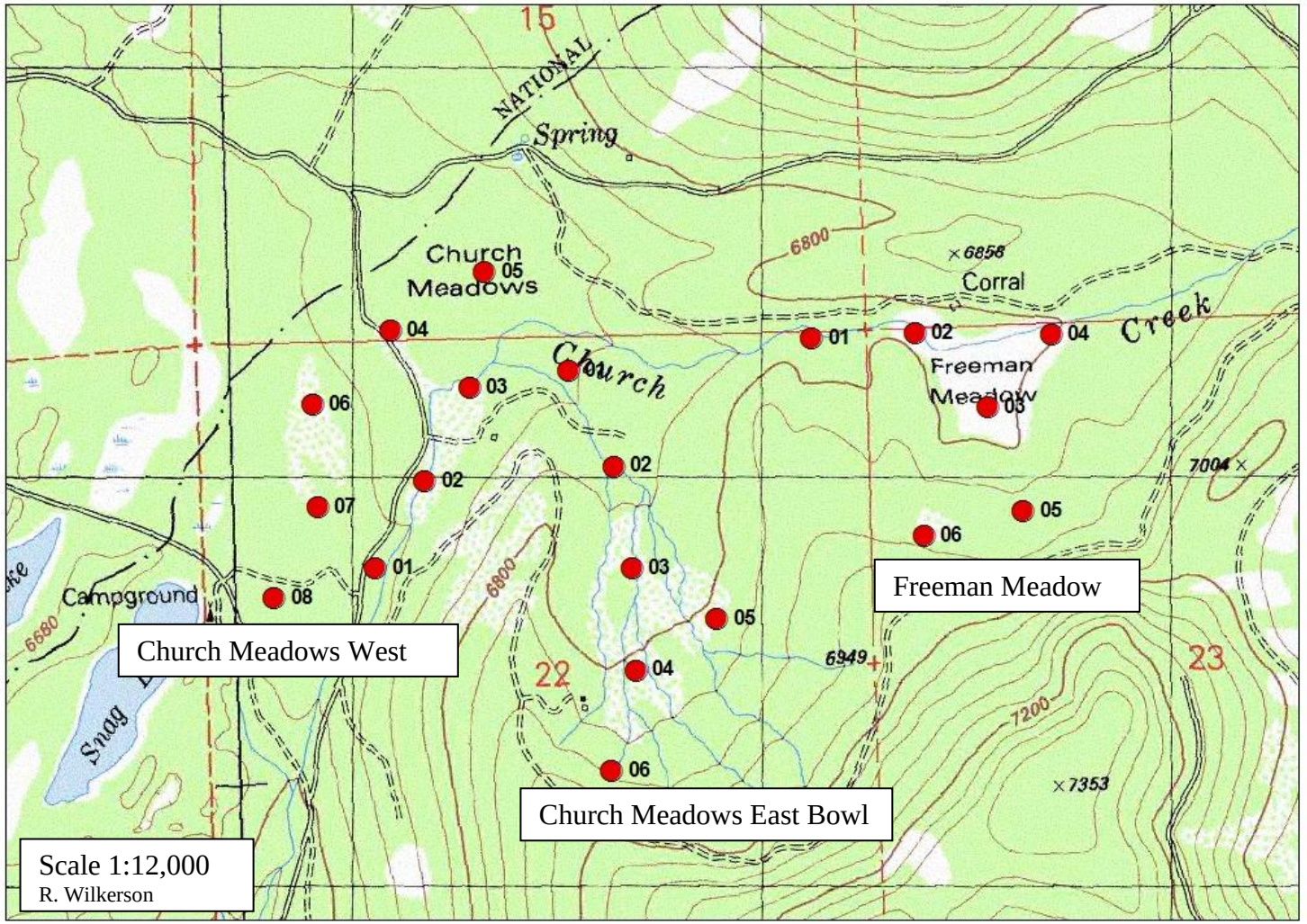
[a]UTM coordinates projected in NAD 83.

Appendix B. Maps of meadows with survey station locations.

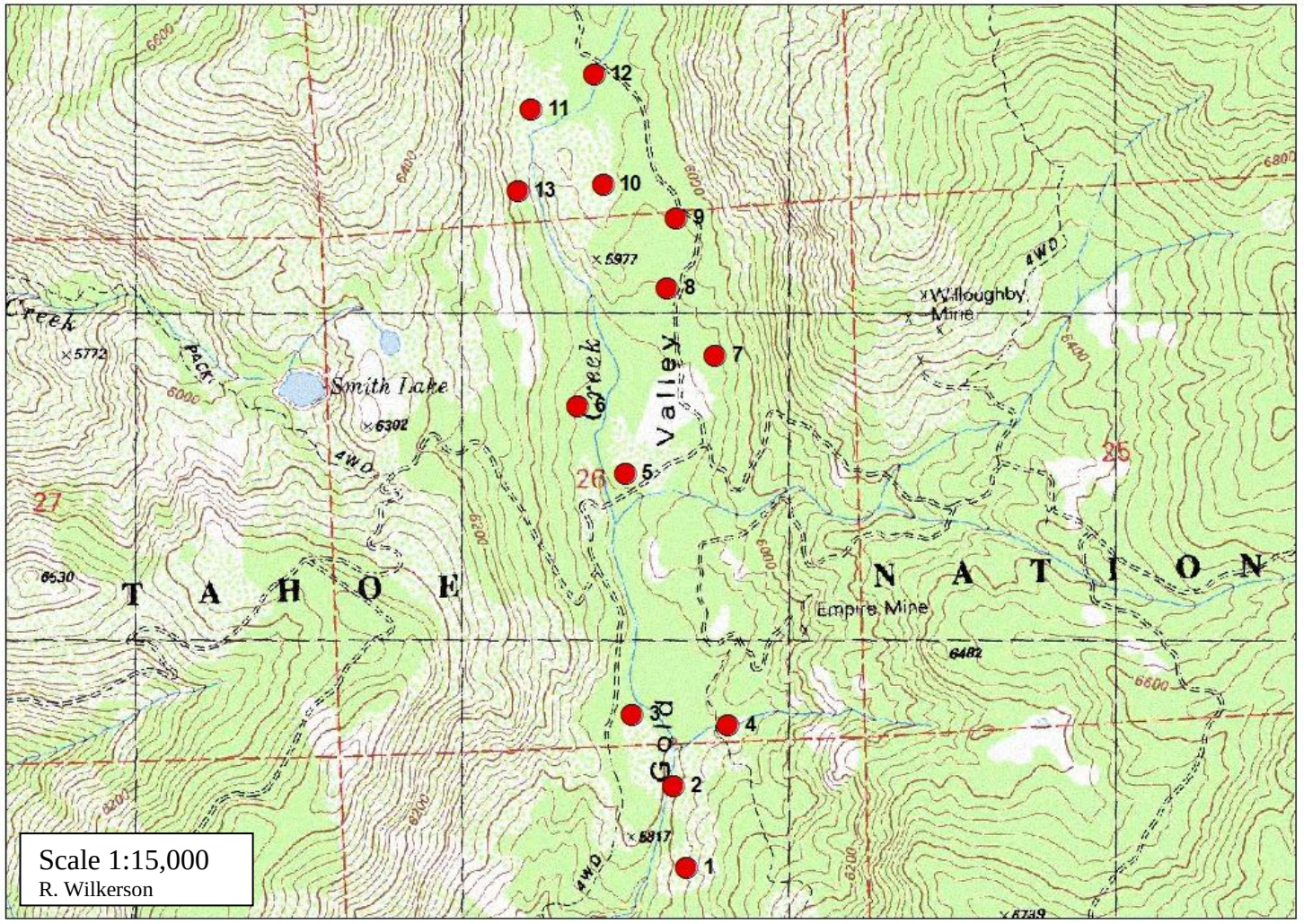
Map B-1. Butcher Ranch



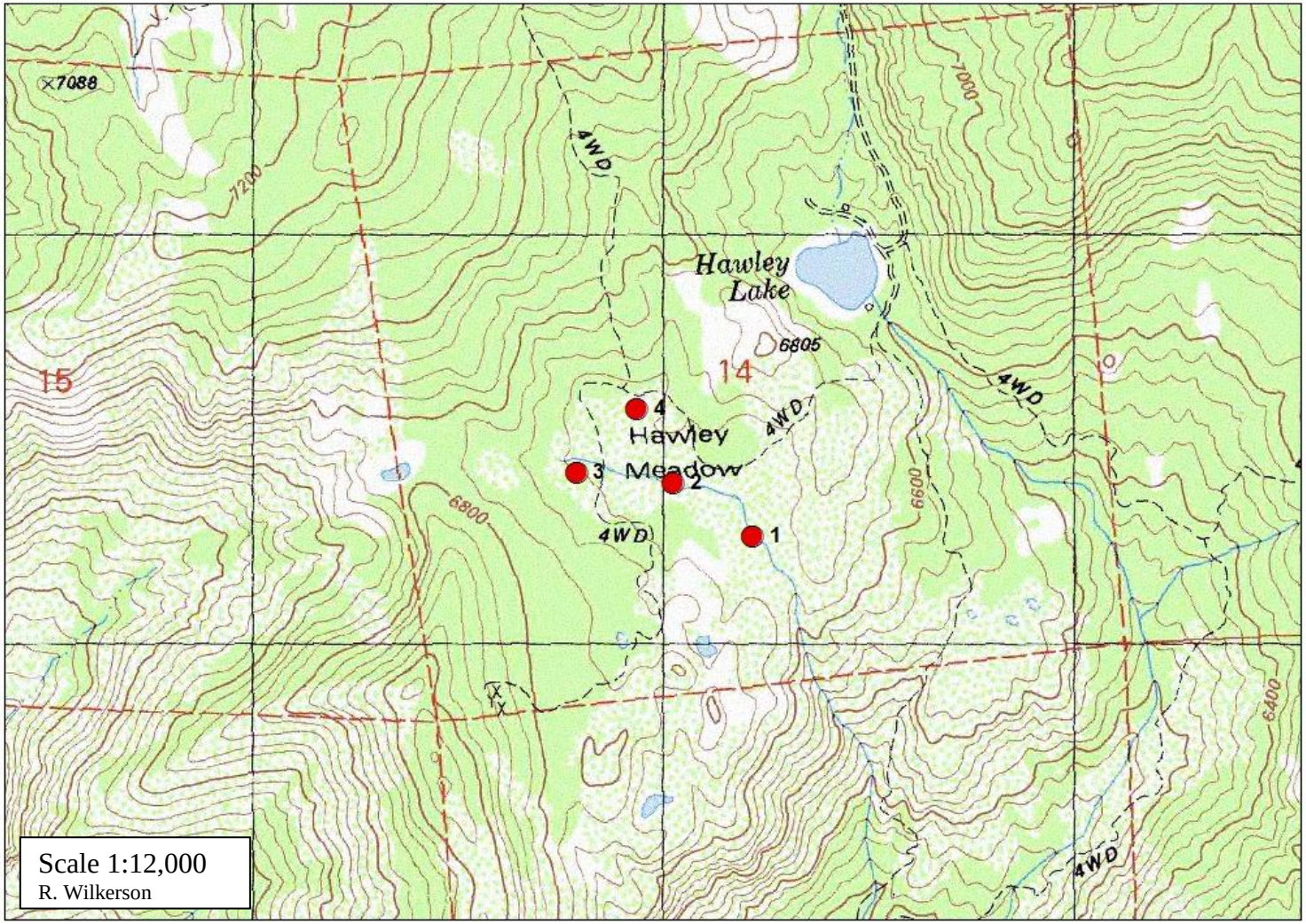
Map B-2. Church Meadow West, Church Meadow East Bowl, Freeman Meadow



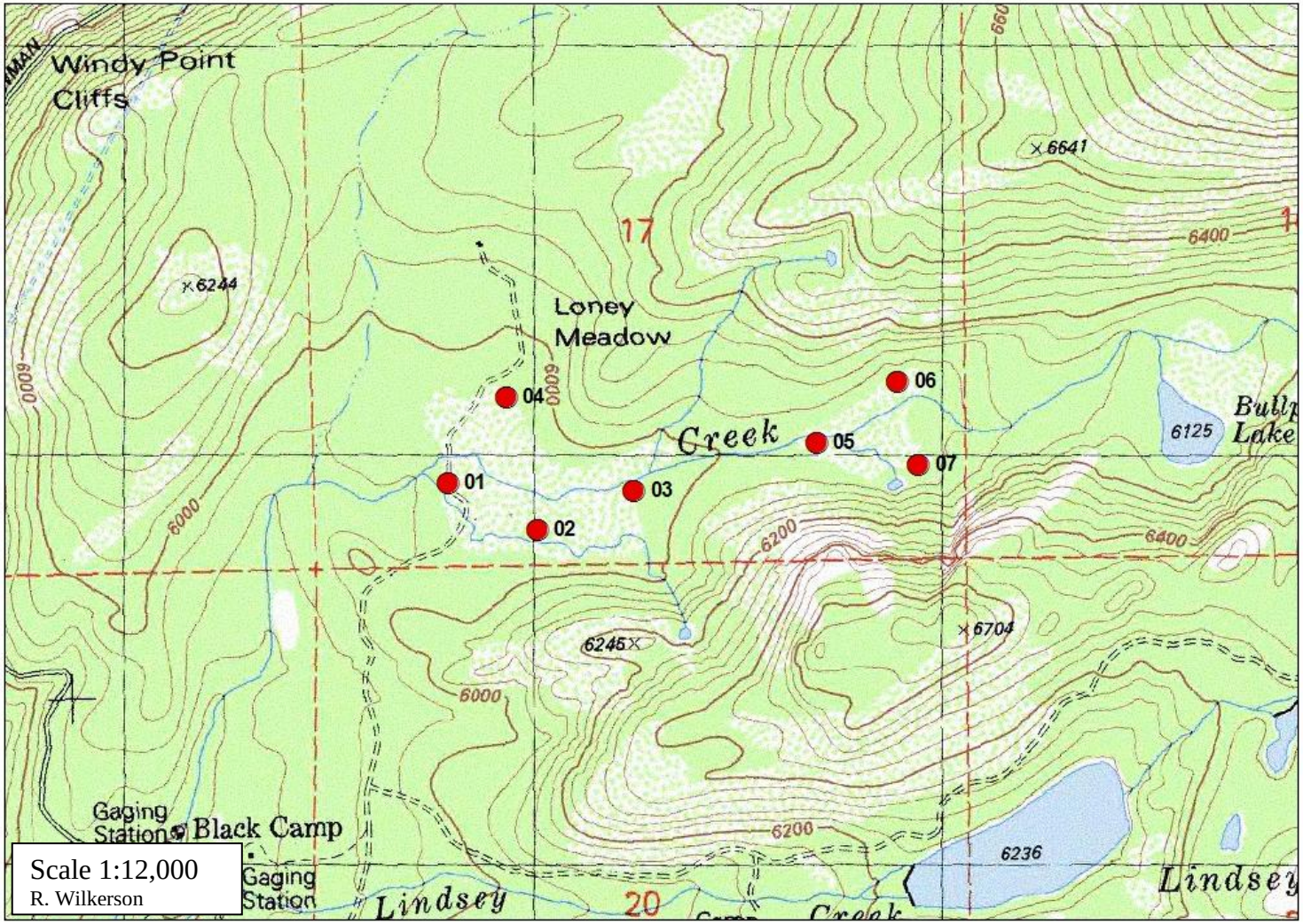
Map B-3. Gold Valley



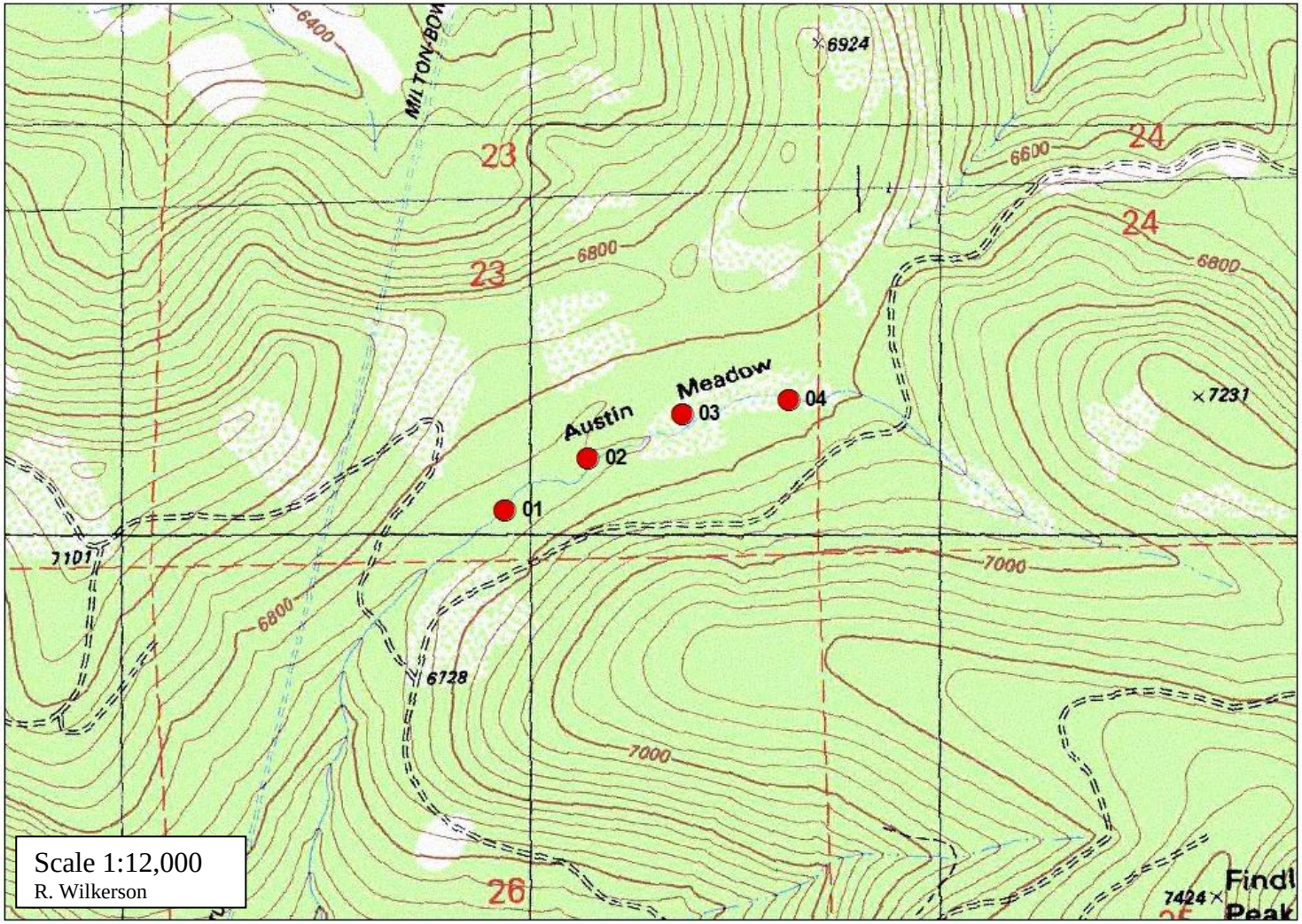
Map B-4. Hawley Meadow



Map B-5. Loney Meadow



Map B-6. Austin Meadow



Appendix C. Number of birds detected during point counts at each meadow

Table C-1. Number of birds detected during point counts at Butcher Ranch and Church Meadow West.

	Butcher Ranch (n = 11 survey station)				***Church Meadow West (n = 8 survey stations)***			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***		***Avg. No. of Birds Detected[a]***		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
Mallard	0.00	0.00	0.00	0.00	1.00	1.00	0.13	0.13
Mountain Quail	0.00	7.50	0.00	0.68	0.00	1.50	0.00	0.19
Sandhill Crane	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**	**0.00**	**0.13**
Spotted Sandpiper	**0.00**	**0.50**	**0.00**	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**
Rufous Hummingbird	0.00	0.00	0.00	0.00	0.50	0.50	0.06	0.06
Red-breasted Sapsucker	**0.00**	**0.00**	**0.00**	**0.00**	**0.50**	**0.50**	**0.06**	**0.06**
Hairy Woodpecker	0.00	1.00	0.00	0.09	0.00	0.00	0.00	0.00
White-headed Woodpecker	0.50	1.00	0.05	0.09	0.00	0.00	0.00	0.00
Northern Flicker	0.50	3.50	0.05	0.32	0.00	2.00	0.00	0.25
Western Wood-Pewee	0.00	12.50	0.00	1.14	0.50	12.50	0.06	1.56
Dusky Flycatcher	0.00	1.50	0.00	0.14	0.50	3.50	0.06	0.44
Black Phoebe	0.00	0.50	0.00	0.05	0.00	0.00	0.00	0.00
Warbling Vireo	**1.00**	**11.00**	**0.09**	**1.00**	**3.50**	**11.00**	**0.44**	**1.38**
Steller's Jay	0.00	6.50	0.00	0.59	0.00	1.00	0.00	0.13
Mountain Chickadee	0.50	6.50	0.05	0.59	2.50	13.00	0.31	1.63
Red-breasted Nuthatch	0.00	1.50	0.00	0.14	0.00	5.00	0.00	0.63
White-breasted Nuthatch	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.06
Brown Creeper	0.00	2.00	0.00	0.18	0.50	3.50	0.06	0.44
House Wren	0.00	0.50	0.00	0.05	0.00	1.00	0.00	0.13
Golden-crowned Kinglet	0.00	4.00	0.00	0.36	0.00	0.50	0.00	0.06
Hermit Thrush	0.00	1.50	0.00	0.14	0.00	0.00	0.00	0.00
American Robin	0.50	12.50	0.05	1.14	2.50	10.00	0.31	1.25
Nashville Warbler	0.00	1.00	0.00	0.09	0.00	0.00	0.00	0.00
Yellow Warbler	**0.50**	**4.00**	**0.05**	**0.36**	**0.50**	**0.50**	**0.06**	**0.06**
Yellow-rumped Warbler	0.00	9.00	0.00	0.82	3.00	9.50	0.38	1.19
Hermit Warbler	0.00	0.00	0.00	0.00	0.50	0.50	0.06	0.06

	Butcher Ranch (n = 11 survey station)				***Church Meadow West (n = 8 survey stations)***			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***		***Avg. No. of Birds Detected[a]***		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
MacGillivray's Warbler	**0.50**	**3.00**	**0.05**	**0.27**	**0.00**	**1.50**	**0.00**	**0.19**
Wilson's Warbler	**2.00**	**11.50**	**0.18**	**1.05**	**1.00**	**2.50**	**0.13**	**0.31**
Western Tanager	0.00	2.50	0.00	0.23	0.00	0.00	0.00	0.00
Green-tailed Towhee	0.50	5.00	0.05	0.45	0.00	0.00	0.00	0.00
Chipping Sparrow	0.50	0.50	0.05	0.05	0.00	0.00	0.00	0.00
Fox Sparrow	0.50	5.00	0.05	0.45	1.00	1.00	0.13	0.13
Song Sparrow	**1.00**	**5.50**	**0.09**	**0.50**	**0.50**	**1.00**	**0.06**	**0.13**
Lincoln's Sparrow	**0.00**	**6.00**	**0.00**	**0.55**	**3.50**	**11.50**	**0.44**	**1.44**
White-crowned Sparrow	**0.00**	**0.00**	**0.00**	**0.00**	**3.50**	**9.00**	**0.44**	**1.13**
Dark-eyed Junco	3.00	10.50	0.27	0.95	5.00	12.50	0.63	1.56
Red-winged Blackbird	1.50	5.50	0.14	0.50	0.00	0.00	0.00	0.00
Brewer's Blackbird	0.50	3.50	0.05	0.32	0.00	0.00	0.00	0.00
Brown-headed Cowbird	**0.00**	**2.00**	**0.00**	**0.18**	**0.00**	**1.50**	**0.00**	**0.19**
Cassin's Finch	0.00	1.50	0.00	0.14	0.00	0.50	0.00	0.06

[a]Number of individuals 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] Only includes birds detected within 50m of a survey point. [d]All birds detected regardless of distance from survey station. [e]Meadow focal species indicated in bold text.

Table C-2. Number of birds detected during point counts at Church Meadow East Bowl.

	Church Meadow East Bowl (n = 6 survey stations)			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
Rufous Hummingbird	1.00	1.50	0.17	0.25
Red-breasted Sapsucker	**0.00**	**1.50**	**0.00**	**0.25**
White-headed Woodpecker	0.00	0.50	0.00	0.08
Northern Flicker	0.00	2.50	0.00	0.42
Western Wood-Pewee	1.00	7.50	0.17	1.25
Dusky Flycatcher	0.50	4.00	0.08	0.67
Pacific-slope Flycatcher	0.00	0.50	0.00	0.08
Warbling Vireo	**0.00**	**5.50**	**0.00**	**0.92**
Steller's Jay	0.50	6.00	0.08	1.00
Clark's Nutcracker	0.00	0.50	0.00	0.08
Common Raven	1.00	2.00	0.17	0.33
Mountain Chickadee	0.00	6.00	0.00	1.00
Red-breasted Nuthatch	0.00	1.00	0.00	0.17
Brown Creeper	0.00	1.50	0.00	0.25
American Robin	1.50	7.50	0.25	1.25
Yellow-rumped Warbler	2.50	5.00	0.42	0.83
Hermit Warbler	0.00	1.00	0.00	0.17
MacGillivray's Warbler	**0.50**	**0.50**	**0.08**	**0.08**
Wilson's Warbler	**1.50**	**4.00**	**0.25**	**0.67**
Western Tanager	0.00	0.50	0.00	0.08
Green-tailed Towhee	0.00	1.00	0.00	0.17
Fox Sparrow	0.50	1.50	0.08	0.25
Song Sparrow	**0.00**	**0.50**	**0.00**	**0.08**
Lincoln's Sparrow	**3.50**	**11.50**	**0.58**	**1.92**
White-crowned Sparrow	**2.50**	**10.50**	**0.42**	**1.75**
Dark-eyed Junco	4.00	9.50	0.67	1.58
Brewer's Blackbird	0.00	0.50	0.00	0.08
Pine Grosbeak	0.50	0.50	0.08	0.08
Purple Finch	0.00	1.00	0.00	0.17
Pine Siskin	0.00	0.50	0.00	0.08
Evening Grosbeak	0.00	1.50	0.00	0.25

[a]Number of individuals 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] Only includes birds detected within 50m of a survey point. [d]All birds detected regardless of distance from survey station. [e]Meadow focal species indicated in bold text.

Table C-3. Number of birds detected during point counts at Freeman Meadow.

	Freeman Meadow (n = 6 survey stations)			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
Mountain Quail	0.00	0.50	0.00	0.08
Northern Harrier	0.50	0.50	0.08	0.08
Calliope Hummingbird	1.00	1.50	0.17	0.25
Rufous Hummingbird	0.50	0.50	0.08	0.08
Red-breasted Sapsucker	**0.00**	**1.00**	**0.00**	**0.17**
Hairy Woodpecker	0.50	0.50	0.08	0.08
Northern Flicker	0.00	0.50	0.00	0.08
Western Wood-Pewee	0.00	7.00	0.00	1.17
Dusky Flycatcher	0.00	1.00	0.00	0.17
Warbling Vireo	1.00	4.50	0.17	0.75
Steller's Jay	0.50	6.00	0.08	1.00
Common Raven	0.00	1.00	0.00	0.17
Mountain Chickadee	1.50	8.00	0.25	1.33
Red-breasted Nuthatch	0.00	4.50	0.00	0.75
Brown Creeper	1.00	4.00	0.17	0.67
Golden-crowned Kinglet	0.00	2.50	0.00	0.42
Hermit Thrush	0.00	1.50	0.00	0.25
American Robin	1.50	12.00	0.25	2.00
Orange-crowned Warbler	0.00	0.50	0.00	0.08
Yellow-rumped Warbler	1.00	2.50	0.17	0.42
MacGillivray's Warbler	**0.00**	**1.00**	**0.00**	**0.17**
Wilson's Warbler	1.00	3.00	0.17	0.50
Western Tanager	0.00	1.50	0.00	0.25
Chipping Sparrow	0.00	0.50	0.00	0.08
Fox Sparrow	0.00	1.00	0.00	0.17
Lincoln's Sparrow	**2.50**	**8.50**	**0.42**	**1.42**
White-crowned Sparrow	**0.50**	**5.00**	**0.08**	**0.83**
Dark-eyed Junco	6.50	13.00	1.08	2.17
Brewer's Blackbird	0.00	0.50	0.00	0.08
Pine Grosbeak	0.00	1.00	0.00	0.17
Cassin's Finch	0.00	1.00	0.00	0.17
Evening Grosbeak	0.00	2.00	0.00	0.33

[a]Number of individuals 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] Only includes birds detected within 50m of a survey point. [d]All birds detected regardless of distance from survey station. [e]Meadow focal species indicated in bold text.

Table C-4. Number of birds detected during point counts at Loney Meadow and Austin Meadow.

	Loney Meadow (n = 7 survey stations)				***Austin Meadow (n = 4 survey stations)***			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***		***Avg. No. of Birds Detected[a]***		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
Mountain Quail	0.00	2.00	0.00	0.29	0.00	0.50	0.00	0.13
Osprey	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.13
Spotted Sandpiper	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.50**	**0.00**	**0.63**
Anna's Hummingbird	1.00	1.00	0.14	0.14	0.00	0.00	0.00	0.00
Downy Woodpecker	0.00	1.00	0.00	0.14	0.00	0.00	0.00	0.00
Northern Flicker	0.00	1.00	0.00	0.14	0.00	0.50	0.00	0.13
Pileated Woodpecker	0.00	1.00	0.00	0.14	0.00	0.50	0.00	0.13
Olive-sided Flycatcher	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.13
Western Wood-Pewee	0.00	10.00	0.00	1.43	0.00	8.00	0.00	2.00
Cassin's Vireo	1.00	1.00	0.14	0.14	0.00	0.00	0.00	0.00
Warbling Vireo	**0.00**	**11.00**	**0.00**	**1.57**	**0.00**	**5.50**	**0.00**	**1.38**
Steller's Jay	0.00	4.00	0.00	0.57	0.00	2.50	0.00	0.63
Common Raven	0.00	4.00	0.00	0.57	0.00	0.00	0.00	0.00
Tree Swallow	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.13
Mountain Chickadee	0.00	2.00	0.00	0.29	0.00	6.50	0.00	1.63
Red-breasted Nuthatch	0.00	4.00	0.00	0.57	0.00	1.00	0.00	0.25
Brown Creeper	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.25
House Wren	0.00	1.00	0.00	0.14	0.00	0.00	0.00	0.00
Golden-crowned Kinglet	0.00	1.00	0.00	0.14	0.00	2.50	0.00	0.63
Hermit Thrush	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.38
American Robin	1.00	9.00	0.14	1.29	1.00	13.50	0.25	3.38
Yellow Warbler	**0.00**	**4.00**	**0.00**	**0.57**	**0.00**	**1.00**	**0.00**	**0.25**
Yellow-rumped Warbler	0.00	4.00	0.00	0.57	0.50	2.50	0.13	0.63
Hermit Warbler	0.00	1.00	0.00	0.14	0.00	0.00	0.00	0.00
MacGillivray's Warbler	**0.00**	**1.00**	**0.00**	**0.14**	**0.00**	**0.00**	**0.00**	**0.00**
Wilson's Warbler	**0.00**	**1.00**	**0.00**	**0.14**	**0.50**	**5.50**	**0.13**	**1.38**
Western Tanager	0.00	1.00	0.00	0.14	0.00	0.50	0.00	0.13
Green-tailed Towhee	0.00	4.00	0.00	0.57	0.00	0.00	0.00	0.00
Fox Sparrow	1.00	4.00	0.14	0.57	1.00	3.50	0.25	0.88

	Loney Meadow (n = 7 survey stations)				***Austin Meadow (n = 4 survey stations)***			
	Avg. No. of Birds Detected[a]		***Avg. No. of Birds per Station[b]***		***Avg. No. of Birds Detected[a]***		***Avg. No. of Birds per Station[b]***	
Species[e]	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***	***<50m[c]***	***Unlimited Radius[d]***
Song Sparrow	**0.00**	**1.00**	**0.00**	**0.14**	**0.00**	**0.00**	**0.00**	**0.00**
Lincoln's Sparrow	**1.00**	**8.00**	**0.14**	**1.14**	**0.50**	**6.50**	**0.13**	**1.63**
White-crowned Sparrow	**0.00**	**2.00**	**0.00**	**0.29**	**2.50**	**3.50**	**0.63**	**0.88**
Dark-eyed Junco	0.00	7.00	0.00	1.00	1.00	5.00	0.25	1.25
Black-headed Grosbeak	0.00	1.00	0.00	0.14	0.00	0.00	0.00	0.00
Red-winged Blackbird	9.00	24.00	1.29	3.43	0.50	6.00	0.13	1.50
Brewer's Blackbird	0.00	3.00	0.00	0.43	0.00	2.00	0.00	0.50
Brown-headed Cowbird	**2.00**	**3.00**	**0.29**	**0.43**	**0.00**	**0.50**	**0.00**	**0.13**

[a]Number of individuals 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] Only includes birds detected within 50m of a survey point. [d]All birds detected regardless of distance from survey station. [e]Meadow focal species indicated in bold text.

Appendix D. Average number of birds detected during area searches at each site

Table D-1. Average number of birds detected during area searches at Butcher Ranch (110 ac./ 45 ha).

Species[a]	*Avg. No. Of Birds Detected*		
	Meadow	*Upland*	*Total*
Mountain Quail	0.0	7.0	7.0
Spotted Sandpiper	**1.0**	**0.0**	**1.0**
Hairy Woodpecker	0.0	1.0	1.0
White-headed Woodpecker	0.0	2.0	2.0
Northern Flicker	0.0	7.0	7.0
Pileated Woodpecker	1.0	0.0	1.0
Western Wood-Pewee	0.0	12.0	12.0
Dusky Flycatcher	1.0	6.0	7.0
Warbling Vireo	**1.5**	**9.5**	**11.0**
Steller's Jay	0.0	8.5	8.5
Mountain Chickadee	3.0	9.0	12.0
Red-breasted Nuthatch	0.0	4.0	4.0
Brown Creeper	0.0	3.0	3.0
House Wren	1.0	0.0	1.0
Golden-crowned Kinglet	0.0	7.0	7.0
Swainson's Thrush	3.0	0.0	3.0
Hermit Thrush	0.5	1.0	1.5
American Robin	4.5	7.0	11.5
Nashville Warbler	0.0	4.0	4.0
Yellow Warbler	**3.5**	**1.0**	**4.5**
Yellow-rumped Warbler	3.0	5.5	8.5
MacGillivray's Warbler	**1.0**	**3.0**	**4.0**
Wilson's Warbler	**6.0**	**3.5**	**9.5**
Western Tanager	0.0	4.0	4.0
Green-tailed Towhee	5.0	3.5	8.5
Chipping Sparrow	2.0	0.0	2.0
Fox Sparrow	5.5	0.0	5.5
Song Sparrow	**4.5**	**0.0**	**4.5**
Lincoln's Sparrow	**5.5**	**0.0**	**5.5**
Dark-eyed Junco	5.0	12.5	17.5
Red-winged Blackbird	5.0	0.0	5.0
Brewer's Blackbird	2.0	0.5	2.5
Brown-headed Cowbird	**1.0**	**2.5**	**3.5**
Cassin's Finch	0.0	2.0	2.0

[a]Meadow-associated focal species are indicated in bold text.

Table D-2. Average number of birds detected during area searches at Church Meadow West (47ac./ 19 ha).

Species[a]	***Avg. No. Of Birds Detected***		
	Meadow	***Upland***	***Total***
Mallard	2.0	0.0	2.0
Mountain Quail	0.0	1.0	1.0
Sandhill Crane	**2.0**	**0.0**	**2.0**
Rufous Hummingbird	1.0	0.0	1.0
Red-breasted Sapsucker	0.0	1.5	1.5
Hairy Woodpecker	0.0	1.0	1.0
Northern Flicker	1.0	0.0	1.0
Western Wood-Pewee	1.5	7.0	8.5
Hammond's Flycatcher	1.0	0.0	1.0
Dusky Flycatcher	2.0	0.0	2.0
Cassin's Vireo	0.0	1.0	1.0
Warbling Vireo	**3.5**	**4.0**	**7.5**
Steller's Jay	0.0	3.0	3.0
Mountain Chickadee	1.5	9.5	11.0
Red-breasted Nuthatch	0.0	4.5	4.5
White-breasted Nuthatch	0.0	1.0	1.0
Brown Creeper	0.0	2.0	2.0
House Wren	2.0	1.0	3.0
Golden-crowned Kinglet	0.0	1.0	1.0
American Robin	4.0	6.5	10.5
Nashville Warbler	0.0	1.0	1.0
Yellow Warbler	**1.0**	**0.0**	**1.0**
Yellow-rumped Warbler	4.0	6.5	10.5
MacGillivray's Warbler	**0.0**	**2.0**	**2.0**
Wilson's Warbler	**3.5**	**0.5**	**4.0**
Fox Sparrow	4.0	0.0	4.0
Lincoln's Sparrow	**8.5**	**1.5**	**10.0**
White-crowned Sparrow	**9.0**	**0.0**	**9.0**
Dark-eyed Junco	4.5	12.0	16.5
Brewer's Blackbird	0.0	2.0	2.0
Brown-headed Cowbird	**1.0**	**0.0**	**1.0**
Cassin's Finch	1.0	2.0	3.0
Pine Siskin	3.0	0.0	3.0

[a]Meadow-associated focal species are indicated in bold text.

Table D-3. Average number of birds detected during area searches at Church Meadow East Bowl (54 ac./22 ha).

	Avg. No. Of Birds Detected		
Species[a]	***Meadow***	***Upland***	***Total***
Rufous Hummingbird	2.0	3.0	5.0
Red-breasted Sapsucker	**0.5**	**2.5**	**3.0**
Hairy Woodpecker	0.0	2.0	2.0
White-headed Woodpecker	0.0	3.0	3.0
Northern Flicker	0.0	4.0	4.0
Western Wood-Pewee	1.5	12.0	13.5
Dusky Flycatcher	2.5	3.5	6.0
Warbling Vireo	**7.0**	**4.0**	**11.0**
Steller's Jay	0.0	7.5	7.5
Clark's Nutcracker	0.0	1.0	1.0
Common Raven	1.0	0.0	1.0
Mountain Chickadee	2.5	11.5	14.0
Red-breasted Nuthatch	0.0	3.5	3.5
Brown Creeper	0.0	3.5	3.5
Golden-crowned Kinglet	0.0	5.0	5.0
American Robin	10.5	8.0	18.5
Yellow Warbler	**4.0**	**0.0**	**4.0**
Yellow-rumped Warbler	0.5	12.5	13.0
Hermit Warbler	0.0	3.0	3.0
MacGillivray's Warbler	**1.5**	**0.0**	**1.5**
Wilson's Warbler	**10.0**	**1.5**	**11.5**
Western Tanager	0.0	3.0	3.0
Green-tailed Towhee	2.0	1.0	3.0
Fox Sparrow	2.5	1.5	4.0
Song Sparrow	**1.0**	**0.0**	**1.0**
Lincoln's Sparrow	**14.0**	**5.0**	**19.0**
White-crowned Sparrow	**20.5**	**3.0**	**23.5**
Dark-eyed Junco	13.5	17.0	30.5
Brown-headed Cowbird	**2.0**	**0.0**	**2.0**
Pine Grosbeak	0.0	3.0	3.0
Purple Finch	2.0	0.0	2.0
Cassin's Finch	0.0	1.0	1.0
Pine Siskin	0.0	2.0	2.0
Evening Grosbeak	0.0	2.0	2.0

[a]Meadow-associated focal species are indicated in bold text.

Table D-4. Average number of birds detected during area searches at Freeman Meadow (46 ac./19 ha).

	Avg. No. Of Birds Detected		
Species[a]	***Meadow***	***Upland***	***Total***
Mallard	2.0	0.0	2.0
Sandhill Crane	**2.0**	**0.0**	**2.0**
Calliope Hummingbird	4.0	0.0	4.0
Red-breasted Sapsucker	**1.0**	**0.0**	**1.0**
Hairy Woodpecker	0.0	1.0	1.0
Northern Flicker	0.5	0.5	1.0
Western Wood-Pewee	0.0	5.0	5.0
Dusky Flycatcher	0.0	1.0	1.0
Warbling Vireo	**1.5**	**2.0**	**3.5**
Steller's Jay	0.5	2.5	3.0
Common Raven	0.0	1.0	1.0
Mountain Chickadee	1.5	4.5	6.0
Red-breasted Nuthatch	0.0	3.0	3.0
Brown Creeper	0.0	1.5	1.5
Golden-crowned Kinglet	0.0	2.5	2.5
Hermit Thrush	0.0	2.0	2.0
American Robin	3.5	4.5	8.0
Orange-crowned Warbler	2.0	0.0	2.0
Yellow-rumped Warbler	2.0	1.5	3.5
MacGillivray's Warbler	**3.0**	**0.0**	**3.0**
Wilson's Warbler	**2.0**	**0.0**	**2.0**
Western Tanager	0.0	2.0	2.0
Chipping Sparrow	0.0	1.0	1.0
Fox Sparrow	0.5	1.5	2.0
Lincoln's Sparrow	**5.5**	**1.0**	**6.5**
White-crowned Sparrow	**5.0**	**1.5**	**6.5**
Dark-eyed Junco	6.5	6.0	12.5
Brewer's Blackbird	0.0	1.0	1.0
Pine Siskin	3.0	0.0	3.0
Lesser Goldfinch	2.0	2.0	4.0
Evening Grosbeak	0.0	2.0	2.0

[a]Meadow-associated focal species are indicated in bold text.

Table D-5. Average number of birds detected during area searches at Loney Meadow (57ac./23 ha).

Species[a]	***Avg. No. Of Birds Detected***		
	Meadow	***Upland***	***Total***
Mountain Quail	1.0	1.0	2.0
Wilson's Snipe	**1.0**	**0.0**	**1.0**
Anna's Hummingbird	1.0	0.0	1.0
Downy Woodpecker	0.0	1.0	1.0
Northern Flicker	0.0	5.0	5.0
Pileated Woodpecker	0.0	1.0	1.0
Western Wood-Pewee	0.0	10.0	10.0
Cassin's Vireo	0.0	1.0	1.0
Warbling Vireo	**0.0**	**12.0**	**12.0**
Steller's Jay	0.0	5.0	5.0
Common Raven	3.0	1.0	4.0
Mountain Chickadee	0.0	2.0	2.0
Red-breasted Nuthatch	0.0	4.0	4.0
House Wren	1.0	0.0	1.0
Golden-crowned Kinglet	0.0	1.0	1.0
American Robin	7.0	3.0	10.0
Yellow Warbler	**4.0**	**1.0**	**5.0**
Yellow-rumped Warbler	0.0	6.0	6.0
MacGillivray's Warbler	**1.0**	**3.0**	**4.0**
Wilson's Warbler	**4.0**	**0.0**	**4.0**
Western Tanager	0.0	1.0	1.0
Green-tailed Towhee	3.0	1.0	4.0
Fox Sparrow	4.0	0.0	4.0
Song Sparrow	**3.0**	**0.0**	**3.0**
Lincoln's Sparrow	**10.0**	**0.0**	**10.0**
White-crowned Sparrow	**2.0**	**0.0**	**2.0**
Dark-eyed Junco	0.0	8.0	8.0
Black-headed Grosbeak	0.0	1.0	1.0
Red-winged Blackbird	30.0	0.0	30.0
Brewer's Blackbird	3.0	0.0	3.0
Brown-headed Cowbird	**6.0**	**0.0**	**6.0**

[a]Meadow-associated focal species are indicated in bold text.

Table D-6. Average number of birds detected during area searches at Austin Meadow (45 ac./18 ha).

Species[a]	***Avg. No. Of Birds Detected***		
	Meadow	***Upland***	***Total***
Mallard	2.0	0.0	2.0
Mountain Quail	0.0	1.0	1.0
Osprey	0.0	1.0	1.0
Killdeer	1.0	0.0	1.0
Spotted Sandpiper	**3.5**	**0.0**	**3.5**
Red-breasted Sapsucker	0.0	1.5	1.5
Northern Flicker	0.0	1.5	1.5
Pileated Woodpecker	0.0	1.0	1.0
Olive-sided Flycatcher	0.0	1.5	1.5
Western Wood-Pewee	0.0	11.0	11.0
Dusky Flycatcher	0.0	2.0	2.0
Warbling Vireo	**3.0**	**3.5**	**6.5**
Steller's Jay	0.0	3.5	3.5
Tree Swallow	2.0	0.0	2.0
Mountain Chickadee	1.0	7.5	8.5
Red-breasted Nuthatch	0.0	3.5	3.5
White-breasted Nuthatch	0.0	1.0	1.0
Brown Creeper	0.0	1.0	1.0
Golden-crowned Kinglet	0.0	4.0	4.0
Townsend's Solitaire	0.0	1.0	1.0
Hermit Thrush	0.0	1.5	1.5
American Robin	12.0	6.0	18.0
Yellow Warbler	**2.0**	**0.0**	**2.0**
Yellow-rumped Warbler	1.5	4.0	5.5
Wilson's Warbler	**6.0**	**1.5**	**7.5**
Western Tanager	0.0	2.0	2.0
Fox Sparrow	3.5	1.0	4.5
Lincoln's Sparrow	**8.0**	**1.0**	**9.0**
White-crowned Sparrow	**2.5**	**0.5**	**3.0**
Dark-eyed Junco	3.0	7.5	10.5
Red-winged Blackbird	7.0	0.0	7.0
Brewer's Blackbird	5.0	0.0	5.0
Brown-headed Cowbird	**2.0**	**0.0**	**2.0**

[a]Meadow-associated focal species are indicated in bold text.

Appendix E. All bird species detected during point counts and area searches at each meadow.

Table E-1. All bird species detected during point counts and area searches at each meadow.

Species[a]	***No. Of Meadows With Detections***	***Butcher Ranch***	***Church Meadow West***	***Church Meadow East Bowl***	***Freeman Meadow***	***Loney Meadow***	***Austin Meadow***
Mallard	3		X		X		X
Mountain Quail	5	X	X		X	X	X
Osprey	1						X
Northern Harrier	1				X		
Sandhill Crane	**2**		**X**		**X**		
Killdeer	1						X
Spotted Sandpiper	**2**	**X**					**X**
Wilson's Snipe	**1**					**X**	
Anna's Hummingbird	1					X	
Calliope Hummingbird	1				X		
Rufous Hummingbird	3		X	X	X		
Red-breasted Sapsucker	**4**		**X**	**X**	**X**		**X**
Downy Woodpecker	1					X	
Hairy Woodpecker	4	X	X	X	X		
White-headed Woodpecker	2	X		X			
Northern Flicker	6	X	X	X	X	X	X
Pileated Woodpecker	3	X				X	X
Olive-sided Flycatcher	1						X
Western Wood-Pewee	6	X	X	X	X	X	X
Hammond's Flycatcher	1		X				
Dusky Flycatcher	5	X	X	X	X		X
Pacific-slope Flycatcher	1			X			
Black Phoebe	1	X					
Cassin's Vireo	2		X			X	
Warbling Vireo	**6**	**X**	**X**	**X**	**X**	**X**	**X**
Steller's Jay	6	X	X	X	X	X	X
Clark's Nutcracker	1			X			
Common Raven	3			X	X	X	
Tree Swallow	1						X
Mountain Chickadee	6	X	X	X	X	X	X
Red-breasted Nuthatch	6	X	X	X	X	X	X
White-breasted Nuthatch	2		X				X
Brown Creeper	5	X	X	X	X		X
House Wren	3	X	X			X	
Golden-crowned Kinglet	6	X	X	X	X	X	X
Townsend's Solitaire	1						X
Swainson's Thrush	1	X					

Species[a]	***No. Of Meadows With Detections***	***Butcher Ranch***	***Church Meadow West***	***Church Meadow East Bowl***	***Freeman Meadow***	***Loney Meadow***	***Austin Meadow***
Hermit Thrush	3	X			X		X
American Robin	6	X	X	X	X	X	X
Orange-crowned Warbler	1				X		
Nashville Warbler	2	X	X				
Yellow Warbler	**5**	**X**	**X**	**X**		**X**	**X**
Yellow-rumped Warbler	6	X	X	X	X	X	X
Hermit Warbler	3		X	X		X	
MacGillivray's Warbler	**5**	**X**	**X**	**X**	**X**	**X**	
Wilson's Warbler	**6**	**X**	**X**	**X**	**X**	**X**	**X**
Western Tanager	5	X		X	X	X	X
Green-tailed Towhee	3	X		X		X	
Chipping Sparrow	2	X			X		
Fox Sparrow	6	X	X	X	X	X	X
Song Sparrow	**4**	**X**	**X**	**X**		**X**	
Lincoln's Sparrow	**6**	**X**	**X**	**X**	**X**	**X**	**X**
White-crowned Sparrow	**5**		**X**	**X**	**X**	**X**	**X**
Dark-eyed Junco	6	X	X	X	X	X	X
Black-headed Grosbeak	1					X	
Red-winged Blackbird	3	X				X	X
Brewer's Blackbird	6	X	X	X	X	X	X
Brown-headed Cowbird	**5**	**X**	**X**	**X**		**X**	**X**
Pine Grosbeak	2			X	X		
Purple Finch	1			X			
Cassin's Finch	4	X	X	X	X		
Pine Siskin	3		X	X	X		
Lesser Goldfinch	1				X		
Evening Grosbeak	2			X	X		

[a]Meadow-associated focal species are indicated in bold text.