



## Using birds to inform meadow restoration at Clear Creek Meadow

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Helen Loffland

The Institute for Bird Populations  
P.O. Box 1346  
Point Reyes Station, CA 94956

[www.birdpop.org](http://www.birdpop.org)



Clear Creek Meadow Photo: NAIP imagery; Black-headed Grosbeak (inset) Rick Derevan

## Introduction

This report summarizes the results of pre-restoration multi-species bird monitoring at Clear Creek Meadow. In 2018, The Institute for Bird Populations (IBP) utilized a standard point count protocol to monitor bird species within the Clear Creek Meadow area to provide pre-restoration baseline data (Loffland et al. 2011a). This protocol is used to assess and describe the larger bird community and to detect population-level changes in meadow bird species in response to restoration activities. Clear Creek Meadow was identified as a priority site during team discussions related to Carson Watershed restoration opportunities (Fair et al. 2018) and was one of twenty three sites surveyed in 2018 by IBP as part of multiple meadow restoration monitoring projects funded by The Truckee River Watershed Council and by the Desert Terminal Lake NFWF initiative. Results from all study sites are combined in the discussion to provide regional context.

## Methods

### Multi-species Bird Monitoring

In 2018, Multi-species monitoring (all bird species) in Clear Creek Meadow followed Loffland et al. (2011a). Point counts were conducted at survey stations spaced 200 - 250 m apart, with all individuals of all species seen or heard counted during a 7-minute period.

### Vegetation Monitoring

In 2018 we assessed vegetation, bare ground, surface water, and numerous other biotic and abiotic factors within 50 m of all multi-species point count stations, following Loffland et al. (2011a).

Cover classes were averaged across four quadrants of a 50-m radius circle centered at each point count station, and then averaged across all points within a meadow. These metrics are intended to serve as a point of reference for bird counts but are not intended to replace vegetation monitoring specific to meadow restoration. Habitat characteristics including water cover and riparian shrub cover were estimated because they are known to be particularly important to focal bird species. Additionally, measures of sagebrush and bare ground were recorded because they may provide a rough index of the extent of severely disturbed area within a meadow.

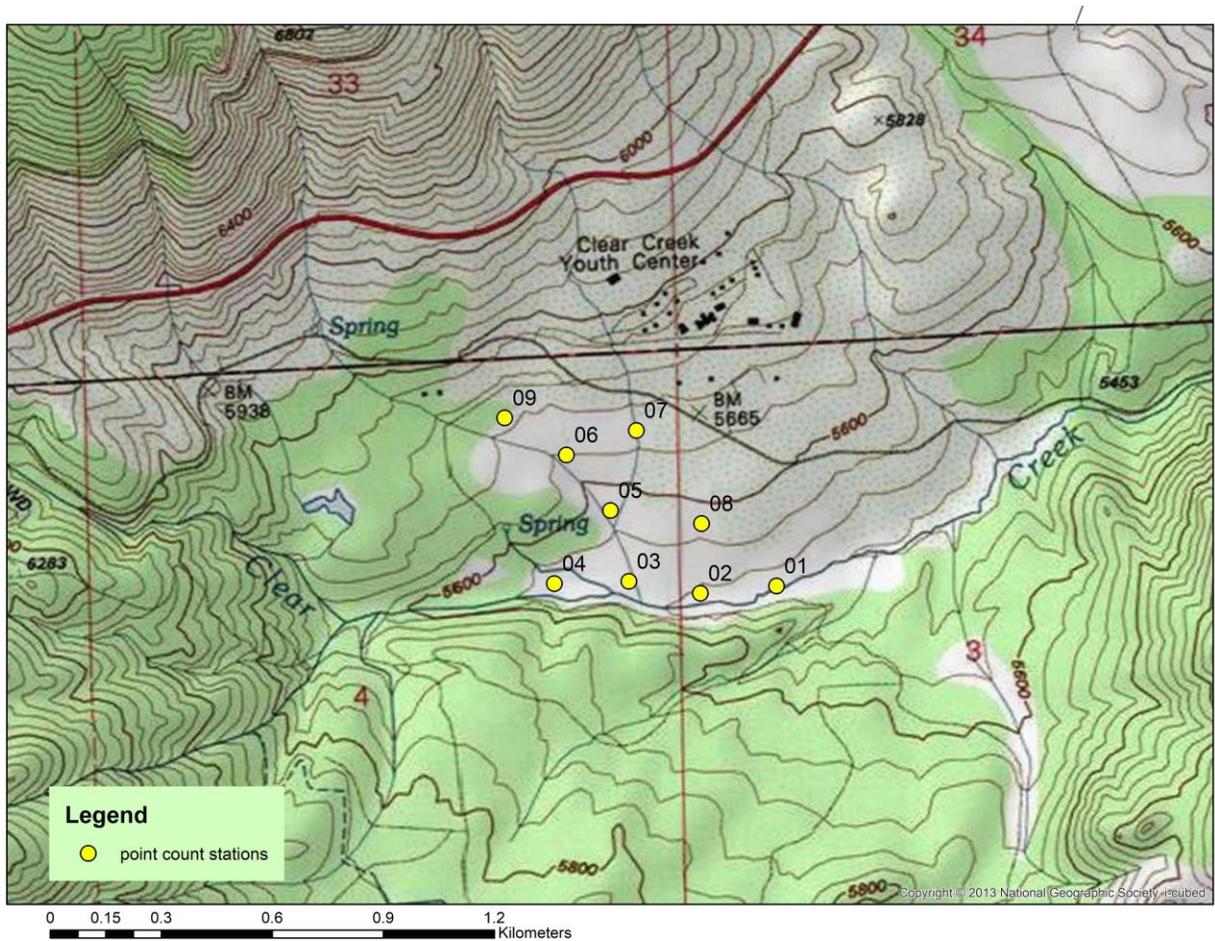
## Results

### Multi-species Bird Monitoring

In 2018 we surveyed 9 multi-species point count survey stations in Clear Creek Meadow (Figure 1). All visits occurred between late May and early July (Table 1).

**Table 1.** Dates for multi-species bird monitoring in the Clear Creek Meadow in 2018.

Site	2018 Visit 1
Clear Creek Meadow	5/28/2018



**Figure 1.** Multispecies avian point count station locations in Clear Creek Meadow.

During Sierra-wide baseline surveys in 2010 and 2012 we selected focal species for analysis based on Loffland et al (2011a), which identifies 18 focal bird species expected to respond positively to meadow restoration, or have other conservation implications making them especially worthy targets of monitoring at meadow restoration sites. In 2013 we worked collaboratively with researchers at Point Blue to refine this list to a smaller subset of focal species (Table 2) most appropriate for analysis based on expected distribution, sample size, and predicted direction of change with restoration (Campos et al. 2014). The observation status for these species and their typical habitat preferences are also indicated in Table 2. In 2018, 33 bird species were detected during point counts at Clear Creek Meadow, including 3 of the focal species (Table 2; Appendix A).

**Table 2.** Focal bird species observation status during surveys of Clear Creek Meadow in 2018.

Species	Usual habitat within meadows <sup>1</sup>	Observed in study area?
Wilson's Snipe	E	no
Red-breasted Sapsucker	S,A	no
Calliope Hummingbird	M,S,A	no
Willow Flycatcher	S,E	no
Swainson's Thrush	S,A	no
Warbling Vireo	S,A	no
Yellow Warbler	S	no
MacGillivray's Warbler	S,A	<b>yes</b>
Wilson's Warbler	S,A	no
Song Sparrow	M	<b>yes</b>
Lincoln's Sparrow	M	no
White-crowned Sparrow	S,M	no
Black-headed Grosbeak	S,A	<b>yes</b>

<sup>1</sup> A= Aspen, cottonwood; E = emergent vegetation and surface water; G = gravel bars and streamside zone; M = open meadow; S = riparian deciduous shrubs

For the purpose of assessing change in these sites over time and in response to future restoration we typically limit our analyses to birds detected within 50 meters of survey stations, in an effort to account for reductions in detection probability that occur with increasing distance from an observer. The following results are based only on detections within 50 m of survey stations unless otherwise noted.

The most common birds included generalist and forest species such as Brewer's Blackbird, Green-tailed Towhee, Chipping Sparrow and riparian associates such as MacGillivray's Warbler and Black-headed Grosbeak (Appendix A). Of particular interest are the meadow focal species (Loffland et al. 2011a, Campos et al. 2014). These species are meadow or riparian associates and are typically found in areas with a mix of shrubby and herbaceous vegetation. During our surveys in 2018 we detected 3 of the focal species at Clear Creek Meadow, but only 1 of those was detected within 50m of survey stations (Tables 2 and 3).

**Table 3.** Total count<sup>1</sup> and index of relative abundance<sup>2</sup> for each focal species detected at Clear Creek Meadow during 2018.

Bird species	Total Count (any distance)	Index of abundance (within 50m) Avg #/acre
MacGillivray's Warbler	3	0.06
Song Sparrow	1	--
Black-headed Grosbeak	4	--

<sup>1</sup>Total count is the sum of all individuals detected at any distance from any point count station

<sup>2</sup>Index of relative abundance calculated as number of individuals detected within 50 m of all point count stations averaged across the number of point count stations per meadow and multiplied by 0.515.

MacGillivray's Warbler was the only focal species detected within 50m of a survey station. We detected two other focal species, Song Sparrow and Black-headed Grosbeak at greater distances. Of our focal species, sparrows have the least restrictive habitat needs and will occur in both wet and dry meadows with varying amounts of riparian or other shrub cover. It was therefore surprising that we only detected one song sparrow (and no Lincoln's or White-crowned sparrows) across the entire site (and none within 50m). The remaining focal species (Table 2) were not detected at all within the study site, likely because they are typically associated with conditions that occur only in relatively small portions of Clear Creek Meadow.

Like White-crowned sparrows, Lincoln's Sparrows tend to be more abundant at higher elevations, but they differ in that they are more strongly associated with mesic meadow conditions and tall, dense herbaceous vegetation, especially where springs or small streams result in sheet flow across the meadow surface. Wilson's Warblers are also more abundant at higher elevations and in meadows with dense willow or other riparian shrub cover and mixed tree cover in more closed stringer-meadow settings. Warbling Vireo and Red-breasted Sapsucker are found along edges where conifers meet the meadows edge, and are especially abundant where there are dense and tall riparian shrubs mixed with riparian deciduous trees. Calliope Hummingbirds require spatially and temporally diverse stands of flowering plants often with a willow mosaic.

These conditions include: flooded areas that include shallow emergent wetland vegetation (Wilson's Snipe), abundant and tall riparian shrub (usually willow) cover in both wet and mesic meadow settings (Yellow Warbler), or dense thickets of riparian shrubs mixed with riparian deciduous trees (Warbling Vireo; Wilson's Warbler, Red-breasted Sapsucker; Ray 1903, Grinnell and Miller 1944, Orr and Moffit 1971, Stewart et al. 1977, Heath and Ballard 2003). Two declining species associated with perennially flooded meadow and riparian habitat in combination with dense shrub cover (Willow Flycatcher, Swainson's Thrush) were also not detected.

In addition to monitoring how individual focal species respond to restoration, we measured an additional metric of restoration success known as "focal species richness" (Campos et al 2014). This metric assesses the number of the 13 target focal species detected at a station, or averaged across stations for the entire site. By monitoring a standard suite of species we can then compare results at Clear Creek Meadow against other sites within the region. The mean in 2018 at Clear Creek Meadow was 0.11 focal species per station (0.06 focal species/acre).

## Discussion

Hydrology is a primary factor restricting habitat quantity and quality for meadow focal bird species. All rely on lush herbaceous and woody vegetation, and the insect food resources (Erman 1984, 1996) associated with saturated or seasonally flooded areas in meadows. Flooded conditions also may provide protection from nest predation, as some mammalian predators avoid surface water (Cain et al 2003, Borgmann 2010, Cocimano et al. 2012). Similarly, many riparian focal species require dense riparian shrubs or trees (aspen, alder, dogwood) that will germinate and grow only with consistent water within the root zone. Although willow requires consistent moisture for germination, mature willow will often persist at a site after meadow hydrology is altered, if roots are deep enough to remain in contact with the water table, despite its lowered elevation. Another factor significantly related to Willow Flycatcher occupancy specifically, and riparian birds generally, is the presence of beaver (Bombay 1999, Cooke and Zack 2008), due to the impoundments beavers create and the subsequent willow germination and recruitment associated with new sediment capture and inundation. Although beaver are present very nearby in the Carson River, in Clear Creek Meadow signs of beaver activity were not noted during point count visits.

Habitat needs of individual meadow-associated bird species are diverse. We believe effective restoration efforts are best informed by considering the needs of the particular species that are being targeted with the restoration efforts. The following discussion is therefore organized around individual meadow focal species or groups of focal species.

### Willow Flycatcher

The California-endangered Willow Flycatcher is the bird species in the region that is most strictly linked to wet meadows dominated by mature stands of willow (Figure 2). Most Willow Flycatcher breeding sites are found in meadows or riparian areas with season-long saturated soils and surface water (Harris et al. 1987, Bombay 1999, Bombay et al. 2003a, b, Mathewson et al. 2012). These conditions may occur in association with oxbows and ponds within a floodplain meadow community or in areas where perennial springs spread water across a variable-gradient meadow surface (Weixelman et al. 2011). Deciduous riparian shrubs, particularly willows, are a critical habitat component for Willow Flycatcher. Most Willow Flycatcher territories contain 50% or more willow cover, typically across a 1- 3 acre area (Bombay 1999). Although Willow Flycatchers are not currently breeding in Clear Creek Meadow, its proximity to historic breeding sites throughout the Carson and Washoe Valleys make future colonization of restored habitat in Clear Creek Meadow a possibility (Mathewson et al. 2011, Loffland et al. 2014, Schofield et al. 2018). This is because even smaller meadows like Clear Creek Meadow that are within close proximity to larger habitat

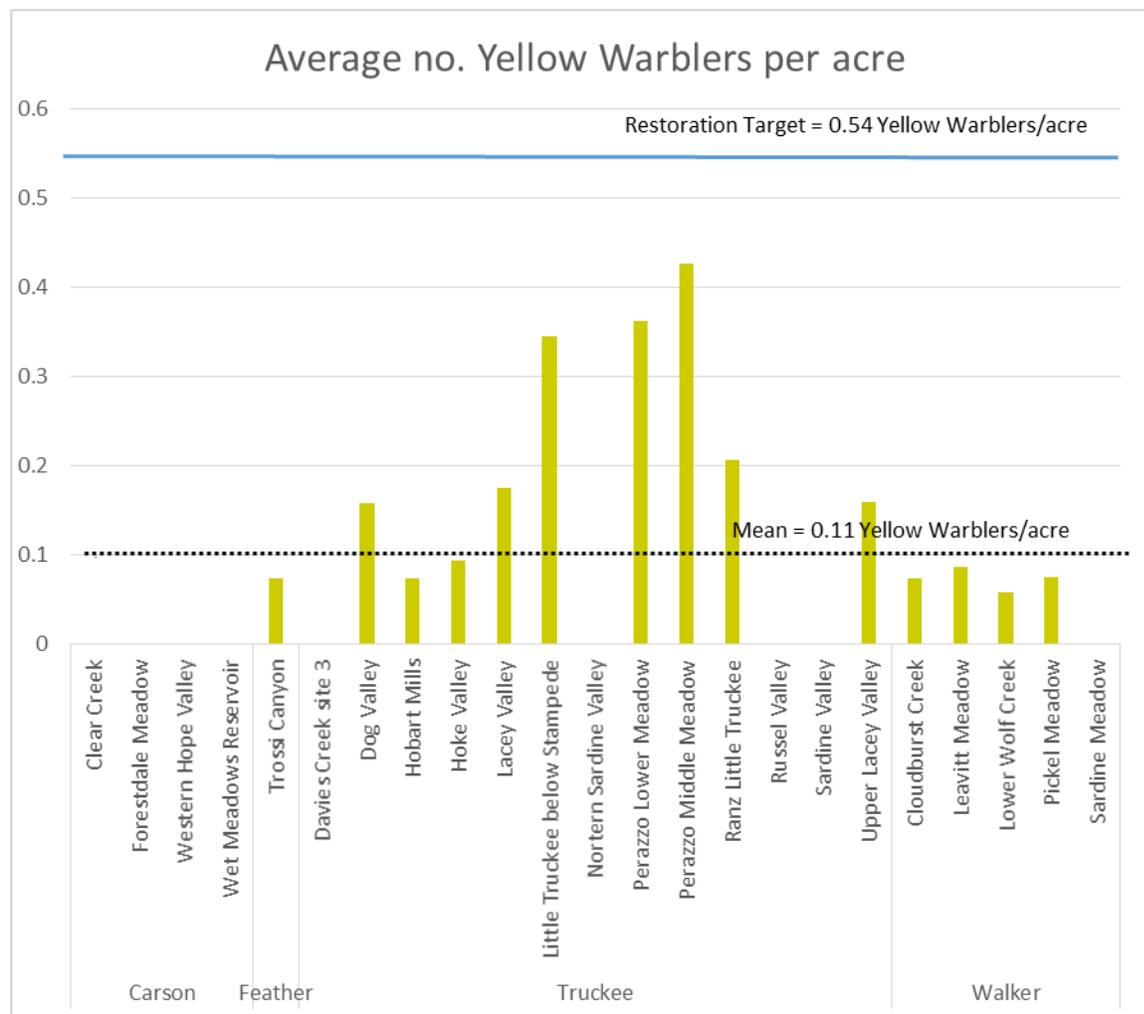


**Figure 2.** Willow Flycatchers are still occasionally found in a few locations in the Carson River watershed.

patches in the valley bottom can act as satellite breeding sites and be maintained over time if enough breeding territories occur nearby. Sites within already occupied watersheds are of highest priority for restoration for this declining species (Schofield et al. in prep). A restoration project that successfully brings overbank flows in contact with a significantly larger portion of the historic floodplain, creates ponded water settings, and results in 3 or more large willow patches (1+ acre in size) could provide suitable habitat for this species. These factors in combination with the presence of beaver nearby suggest that targeted efforts could create habitat for 2 or more Willow Flycatcher territories over the next 10-20 years, if significant wetted areas are created willow establishes within the first 5 years. Sites that support this many territories when close to larger breeding areas (with the potential to support 10 or more territories such as River Fork Ranch complex) are more likely to be self-sustaining breeding sites over time.

### Yellow Warbler

Yellow Warbler, a California Species of Special Concern is, like Willow Flycatcher, strongly linked to dense willow stands. This species is therefore an excellent indicator of the quality of willow habitat in the absence of Willow Flycatchers, although Yellow Warblers are not as limited to extremely wet conditions (Heath 2008). Yellow Warblers do, however, occur in their greatest densities at sites with these characteristics. While relatively common nearby in the appropriate portions of the Carson Valley where tall willow in denser patches is present, willow is absent from Clear Creek Meadow. Campos et al. (2014) recommend a habitat management target of 1.04 Yellow Warblers per station (0.54 Yellow Warblers per acre; Figure 3). If restoration reconnects the water table with the historic floodplain and natural recruitment or willow plantings are successful, new willow stands could mature in 10 to 15 years and could provide habitat for Yellow Warbler. Because Yellow Warblers are present at many nearby riparian areas it is likely they could quickly colonize newly created habitat as new willow stands become larger, taller, and denser.



**Figure 3.** Average number of Yellow Warblers detected per acre at all 2018 survey sites, including Clear Creek Meadow, relative to regional target and regional mean.

Song Sparrow, White-crowned Sparrow, Lincoln’s Sparrow

These sparrow species were either absent or extremely scarce (song sparrow) at Clear Creek Meadow. This is very surprising given that Song and White-crowned sparrow have the least restrictive habitat needs of our focal species. This meadow contains a large area of mesic sedge dominated habitat which would normally support at least a handful of territories for one or two of these species at a minimum. Although not strictly necessary, willow is a preferred component of White-crowned, Lincoln’s and Song Sparrow habitat. If willow cover was expanded and the meadow becomes wetter overall, it is possible that the sparrow populations would also expand at the site. These sparrow species are important for restoration monitoring because their typically larger sample sizes and less restrictive habitat requirements allow for more robust analyses as post-restoration monitoring occurs. We recommend assessing whether the nearby housing developments and golf course could be encouraging higher than average meso-predator populations and negatively affecting these typically ground nesting species.

Red-breasted Sapsucker, Warbling Vireo, Wilson's Warbler, MacGillivray's Warbler, Black-headed Grosbeak

MacGillivray's Warbler was the focal species with the highest index of relative abundance at Clear Creek Meadow (mean relative abundance of 0.11/station or 0.06/acre; Table 2, Figure 4). Only Black-headed Grosbeak was the only other species at the site and none were detected within 50m of survey stations. This may be due to the lack of willow and aspen. All members of this suite of species will likely respond positively to any increases in willow or alder cover that occur with a more natural overbank flooding regime, as a result of active planting, or as a result of other land management changes that improve germination and recruitment to mature lifestages of riparian shrubs and deciduous trees. Restoration activities may extend the length of growing season when the areas further from the streambed are saturated, and may expand some slow-water areas within the area immediately adjacent to the channel. This may allow establishment of aspen stands particularly along tributaries and meadow edges. If overall riparian deciduous shrub heterogeneity and aspen cover increase due to natural regeneration and/or plantings, these bird species could increase substantially, but it may take 10-15 years to establish the needed dense heterogeneous woody stands in some parts of this meadow.



**Figure 4.** Point count stations where MacGillivray’s Warblers were detected. Size of circle indicates number detected (within 50m).

### Wilson’s Snipe

In the Sierra Nevada, this species is found only in marshy emergent vegetation in large meadows (or other wetlands) with flooded oxbows, beaver ponds, or sites with sheet flow occurring across the meadow surface. Wilson’s Snipe are relatively easy to detect and are therefore excellent for monitoring changes to this habitat type after restoration. Wilson’s Snipe were not detected in Clear Creek Meadow. If restoration restores overbank flows, results in sheet flow along other incised springs, and creates ponded areas that mimic oxbows or beaver impoundments, the sedge-dominated nesting cover and the mud/peat foraging requirements of snipe are likely to increase dramatically and could result in colonization by snipe.

### Calliope Hummingbird

Although absent from this site, Calliope Hummingbirds often benefit from wetter meadows with abundant willows. These conditions usually result in more diverse microclimates and longer growing season for the diverse floral resources they require.

### Brown-headed Cowbird

Brown-headed cowbirds are nest parasites that may negatively affect meadow focal species where they are abundant. During our surveys brown-headed cowbirds were regularly detected at Clear Creek Meadow (0.21 BHCO/station, 0.11/acre). We recommend that the monitoring of this species continues because population increases may unravel or hinder restoration related gains for riparian focal species in some instances.

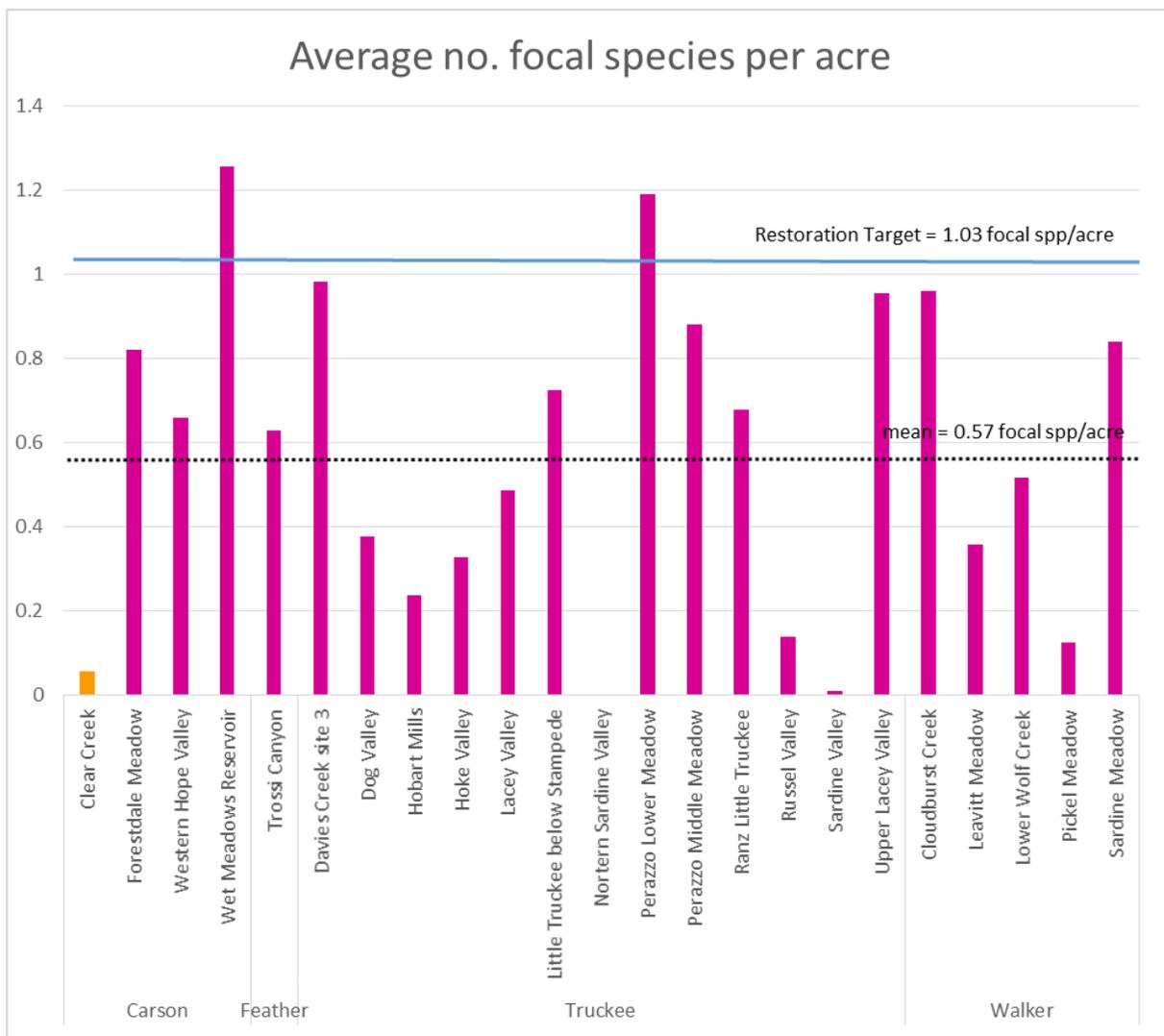
### Multi-species Results

Campos et al. (2014) recommended that management and restoration activities should strive to meet a species richness target of 1.99 focal species per station (or 1.04 focal species per acre). Our current species richness measurement for Clear Creek Meadow is 0.11 focal species/station (0.06 focal species/acre), so meeting that target at the meadow scale will require substantial gains. Clear Creek Meadow is also much lower than the average value of 0.56 focal species/acre as measured across all the restoration monitoring sites visited by IBP in 2018 (Figure 5).



**Figure 5.** Locations within Clear Creek Meadow where one or more focal species were detected within 50m of survey stations. The size of the orange circle indicates number of focal species detected.

Based on assessment of focal species richness values from other sites within the watershed and elsewhere (Figure 6), we suggest that the most reliable way to boost focal species richness is to use restoration techniques that re-wet the drier portions of the meadow and create areas of season-long ponded water, and especially through creating conditions necessary for germination and recruitment of native woody vegetation (and subsequently protecting it from browsing while it becomes established). In sites like Clear Creek Meadow where there is a considerable shortage of riparian shrubs we recommend planting at least a few large patches in an attempt to jump start this habitat component. Similarly, through planting of aspen along meadow edges or within the stream channels where hydrology is appropriate, additional bird species are likely to respond positively over the next 10+ years.



**Figure 6.** Average riparian focal species richness per acre at all 2018 survey sites, including Clear Creek Meadow (yellow bar), relative to regional target and regional mean.

Vegetation Surveys

Clear Creek Meadow has similar flowing water cover values when compared to all sites visited in 2018, but generally lower values for riparian shrubs and standing water, two important components of meadow bird habitat (Table 4).

**Table 4.** Average cover values in percentage of vegetation and hydrology habitat components at all sites visited in 2018

Watershed	Site name	Avg. percent cover by type %					Aspen or cottonwood present?
		Riparian shrub	Sagebrush	Flowing water	Standing water	Tree	
Carson	Clear Creek	1.5	5.7	2.1	0.4	6.8	Yes
Carson	Forestdale Creek	33.3	0.0	2.5	13.8	0.5	
Carson	Hope Valley West Meadow	20.9	20.2	0.8	5.1	13.2	Yes
Carson	Wet Meadows Reservoir	42.1	7.3	0.5	1.5	11.4	Yes
Feather	Trossi Canyon	15.5	28.8	1.5	5.5	26.2	Yes
Truckee	Davies Creek	21.3	19.7	1.5	5.4	7.8	
Truckee	Dog Valley	5.5	19.8	1.2	0.8	0.9	Yes
Truckee	Hobart Mills	4.4	16.7	2.5	4.2	2.5	
Truckee	Hoke Valley	8.0	27.8	2.1	7.0	15.0	Yes
Truckee	Lacey Valley Lower	10.0	0.0	3.3	4.3	1.6	
Truckee	Little Truckee Below Stampede	15.8	23.6	3.0	2.6	6.2	Yes
Truckee	North Sardine Valley	0.6	5.2	0.4	25.3	0.6	
Truckee	Perazzo Lower	26.2	11.8	8.3	0.1	5.8	
Truckee	Perazzo Middle	31.2	10.4	6.9	25.1	8.7	
Truckee	Ranz Little Truckee	20.4	16.2	5.7	1.1	17.1	Yes
Truckee	Russel Valley	1.8	19.8	2.2	3.3	1.5	
Truckee	Sardine Valley	0.1	49.2	1.8	1.2	0.0	
Truckee	Upper Lacey Valley	25.7	0.0	1.1	7.5	16.2	
Walker	Cloudburst Creek	11.9	7.8	2.3	9.3	30.5	Yes
Walker	Leavitt Meadow	15.4	15.7	2.9	0.8	2.5	Yes
Walker	Lower Wolf Creek Meadow	10.9	12.0	4.6	1.3	22.3	Yes
Walker	Pickel Meadow	10.4	11.6	4.3	9.0	0.5	Yes
Walker	Sardine Meadow	17.5	25.0	5.9	0.6	29.6	
	Mean across all sites	11.7	17.2	2.9	4.6	6.4	

## Recommendations

Meadow restoration is a complex and challenging process that is not completed in one season. If restoration actions are undertaken at Clear Creek Meadow they may take many years to create habitat conditions needed for some focal bird species. We recommend continued monitoring efforts at these and other restoration sites so that future practitioners can better understand the complex and temporally dynamic responses of bird populations to restoration of this sort and identify those practices that create the best outcomes for birds, fish, plants, hydrologic systems, recreation, and downstream water users. Long-term monitoring is necessary to generate science-based best management practices.

The primary issue constraining bird habitat quality at Clear Creek Meadow is a lack of mature riparian shrub cover or shrub recruitment. A large portion of the meadow is relatively mesic already (however it does not appear that a hydrologic assessment has occurred to date so locations of hydrologic issues are not well documented). Hydrologic restoration actions such as complete fill, pond and plug, beaver dam analogs and planting and fencing of large patches of willow and other riparian shrubs could improve hydrology and vegetative communities in the shortest time frame and most benefit the region's rapidly declining Willow Flycatcher population at a temporal scale best matching the species' rate of decline. Beaver have not colonized the area, likely due to a lack of hiding cover in the form of deep ponded water. It would be informative to assess whether beaver populations are being actively controlled at the site (or nearby), and how management of beaver could be used to improve conditions. Similarly, season of use and intensity of use by livestock (if being grazed) could be assessed and modified to incorporate or increase rest rotation (or other actions) in the meadow to improve woody vegetation recruitment in areas wet enough to support it. Typically areas that are both wet for most of the season and have dense riparian woody vegetation support a rich insect community and provide hiding and nesting cover. Clear Creek Meadow could benefit from additional riparian shrub plantings (1 acre patches with subsequent fencing to protect against browse if needed). Clear Creek Meadow is also a good candidate area for aspen planting along the meadow edges (or efforts to release any existing aspen stands).

### Recommended Restoration Actions

1. Conduct a hydrologic assessment.
2. Treat incised primary channel and tributaries (via complete fill, pond and plug, beaver dam analogs, etc.) to reduce incision and increase soil saturation, standing water and sheet flow (with subsequent willow, alder, or aspen planting as feasible).
3. Plant and protect willow and other riparian deciduous shrubs in areas where existing or restored hydrology provides necessary flooding and/or soil saturation levels. Plant patches at least 1 acre in size if possible.

4. Plant aspen along meadow edge or treat existing aspen stands to stimulate new growth as feasible.
5. Assess future management plans (grazing, recreation, etc) for the meadow as needed to support hydrologic stability, riparian vegetation recruitment, and restoration goals.

## Climate-Smart context

We are already experiencing the effects of climate change in the Sierra Nevada. Projections suggest that the region is likely to continue to experience profound changes through the end of the 21st century. Rising temperatures, reduced snowpack, changing hydrological conditions, and increased frequency and intensity of extreme events threaten Sierra meadows and meadow-associated species. Restoring Sierra meadows in the context of historical conditions and the range of historic variability is unlikely to be adequate to ensure that desired meadow restoration outcomes, such as hydrological processes and habitat for diverse species, are able to persist under future climate change. In order to retain our investment in meadow restoration, it is necessary to design and implement climate-smart meadow restoration projects in the context of a changing climate and associated uncertainty about future conditions (Veloz et al. 2013), in a manner that makes them resilient to the consequences of climate change. Below we summarize the projections for the Sierra Nevada and outline some climate-smart actions that may increase the likelihood of success. For more information, please see “A guide to climate-smart meadow restoration in the Sierra Nevada and southern Cascades” (Vernon et al. 2019).

Climate Projections. The Sierra Nevada is projected to experience large changes in climate and hydrology by the mid-21st century relative to conditions observed in the 20th century. Below is a summary of projections for the Northern Sierra Nevada from a CA-wide water balance model (Flint et al. 2014) and the Assessment of Climate Change in the Southwest US (Garfin et al. 2013):

- Large reductions in April 1st snowpack
- Higher maximum and minimum daily temperatures throughout the year
- Increased evapotranspiration rates (water demand) by plants in meadows
- Higher proportion of winter precipitation falling as rain instead of snow, including rain on snow
- Larger, longer, and more frequent heavy rain events that cause large floods
- Hotter, longer and more frequent droughts and heat waves
- Increased probability of high severity fire

### Potential Climate-Smart Actions

- Promote beaver occupancy (e.g. by managing for sufficient willow cover) to maintain hydrologic function and increase habitat complexity. In general, Sierra Nevada riparian

meadows historically had a high capacity for beaver dams. Beaver dams prolong floodplain activation and hold more water in the meadow during droughts.

- Plant a diversity of riparian shrubs that occur in the vicinity to increase the duration fruits and flowers are available to wildlife to compensate for divergences in plant and animal phenology. Plant along the channel, meadow edges, and other moisture gradients, and consider sourcing material from drier areas and lower elevations that may be more tolerant of the future climate.
- Identify and plant more drought-tolerant species and phenotypes. Source species for plantings from areas lower in the watershed that are warmer and drier. Plant large numbers of willows cuttings from all willow species in the meadow to increase the likelihood of survival of some individuals following severe drought.
- Provide thermal refugia (shade, shelter, water, and food) for wildlife species by planting willows and other shrub species to promote large clumps of dense foliage with diverse plant understories near and over water. Shrubs and sedges along the stream channel promote complex instream habitat and may reduce stream temperatures by shading.
- If the meadow is grazed, maintain riparian fencing to protect streamside vegetation and adaptively manage grazing pressure to achieve desired objectives, especially during drought years or following major disturbance (e.g. large flood).
- Monitor the restoration project to inform agile and adaptive management, and provide context for understanding climate-related impacts and vulnerabilities.

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**Appendix A.** Bird Species detected during point count surveys in Clear Creek Meadow in 2018, including total number of individuals detected and relative abundance<sup>1</sup>. Tan highlighting indicates meadow focal species.

Bird Species	# detected (all distances)	Index of abundance (within 50m) Avg #/acre
California Quail	8	
Red-tailed Hawk	1	
Mourning Dove	6	
Hairy Woodpecker	1	
White-headed Woodpecker	4	0.06
Northern Flicker	1	
Western Wood-Pewee	20	0.11
Plumbeous Vireo	2	0.06
Steller's Jay	4	0.06
Clark's Nutcracker	1	
Common Raven	1	
Barn Swallow	2	0.11
Mountain Chickadee	6	0.06
White-breasted Nuthatch	1	
Pygmy Nuthatch	5	
House Wren	12	0.06
Townsend's Solitaire	1	
American Robin	5	0.06
Yellow-rumped Warbler	2	
MacGillivray's Warbler	3	0.06
Western Tanager	10	
Green-tailed Towhee	6	0.11
Spotted Towhee	1	0.06
Chipping Sparrow	6	0.11
Song Sparrow	1	
Black-headed Grosbeak	4	
Brewer's Blackbird	9	0.52
Brown-headed Cowbird	4	0.11
Cassin's Finch	3	0.06
House Finch	1	
Pine Siskin	1	
Lesser Goldfinch	6	0.17
Evening Grosbeak	30	

<sup>1</sup> number of individuals detected within 50m radius plot around survey stations divided by the number of station visits and multiplied by 0.515 plots per acre.