Continuing Declines of Grassland Birds in California's Central Valley

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ABSTRACT

Grassland birds of North America are in more rapid and widespread decline than those of any other habitat guild. While most population trend data are based on breeding season surveys, this decline is also evident from studies in the non-breeding season. A study using Christmas Bird Count (CBC) data from California's Central Valley showed highly significant declines in nearly all grassland-associated birds from the late 1970s to 2014 (Pandolfino and Handel 2018). We used data from the same Central Valley CBCs used in that study to demonstrate that this decline has continued through at least 2019 for the American Kestrel (*Falco sparverius*), Loggerhead Shrike (*Lanius ludovicianus*), Horned Lark (*Eremophila alpestris*), American Pipit (*Anthus rubescens*), Lark Sparrow (*Chondestes grammacus*), and Western Meadowlark (*Sturnella neglecta*). The rate of decline for the Loggerhead Shrike and the Horned Lark may have increased in recent years. We also compared the rate of these declines to the loss of grassland habitat in the CBC circles and discuss some of the implications of these findings. The one wintering grassland species that showed a positive trend in earlier studies, the Say's Phoebe (*Sayornis saya*), continued to increase in abundance.

Birds using grasslands as their primary habitat have been in severe, long-term, and widespread decline throughout North America since at least the early 1990s (Droege and Sauer 1993) and more so than for any other avian guild (Knopf 1994). Recently, Rosenberg et al. (2019) and the North American Bird Conservation Initiative (2022) confirmed that these declines have continued. They found that, while many bird species show negative population trends in North America, the declines among grassland birds are the most pronounced of any group. Rosenberg et al. (2019) noted that,

"grassland birds showed the largest magnitude of total population loss since 1970—more than 700 million breeding individuals across 31 species—and the largest proportional loss (53%); 74% of grassland species are declining." The proportion of grassland birds in decline was nearly twice that of any other habitat group.

Conversion of grasslands to urban and intensive agricultural uses has been cited as the most likely causes of loss of grassland birds in California (Hammond et al. 2022) and throughout their range (Vickery and Herkert 2001 and citations therein). However, other factors that affect grassland birds directly and indirectly may be important. Sánchez-Bayo and Wyckhuys (2019) showed that many insect families have been disproportionally affected by grassland conversions, thereby significantly reducing the availability of prey needed by breeding birds. Mineau and Whiteside (2013) suggested that loss of grassland birds in the U.S. may be more due to direct toxicity from agricultural pesticides than from the effects of land conversion or prey reduction. However, Hill et al. (2014) challenged this conclusion with models suggesting habitat loss is a much more significant factor.

The studies supporting declining trends in grassland bird populations have almost exclusively used breeding season data. Trends among wintering grassland birds remain understudied. Indeed, Vickery and Herkert (2001) and Rosenberg et al. (2019) emphasized the need for data on wintering grassland birds. One such study used Christmas Bird Count (CBC) data in the Central Valley of California to examine wintering bird population trends from 1978 to 2014 (Pandolfino and Handel 2018). They found that a larger proportion of birds using grassland/open space as their primary habitat showed significant declines than those of any other habitat group, mirroring the widespread breeding season trends noted above. They found seven species that used grassland/open space as their primary winter habitat showed significant trends with six in decline and just one (Say's Phoebe; *Sayornis saya*) increasing. Declining species included the American Kestrel (*Falco sparverius*), Loggerhead Shrike (*Lanius ludovicianus*), Horned Lark (*Eremophila alpestris*), American Pipit (*Anthus rubescens*), Lark Sparrow (*Chondestes grammacus*), and Western Meadowlark (*Sturnella neglecta*). We examined recent data for those same seven species from the same CBC circles used by Pandolfino and Handel (2018) to determine if those trends had continued for the six years since 2014. We also compared the loss of grassland habitat within those CBC circles to changes in grassland bird abundance. Based on the multiple factors that may be impacting these birds on the breeding and wintering grounds, we predicted that proportional declines in grassland bird abundance would exceed the net proportional reduction in grassland habitat.

METHODS

Following Pandolfino and Handel (2018), we used data (National Audubon Society 2020) from 17 CBC circles in the Central Valley from Redding in the northern Sacramento Valley to Bakersfield in the southern San Joaquin Valley (Figure 1). These counts were conducted during at least two-thirds of the years in the winter period (1978–79 through 2013–14) used by Pandolfino and Handel (2018) and in each of the six subsequent years for our analysis (2014–15 through 2019–2020). All CBC data were normalized using number of birds per party hour to account for variations in effort. We report these data using the CBC Count Year, with Count Year 79 using data from winter of 1978–79, Count Year 80 using winter 1979–80, and so on. We did not use data from Count Years 121 and 122 because some of the Central Valley counts were canceled and others conducted with limited participation due to the COVID-19 pandemic. To assess whether past trends continued for the additional six years, we compared the abundance values from those years to the long-term trendline to determine the number of years those values were above or below that trendline.

Data on changes in grassland/open space land cover were derived from the National Land Cover Database (Nakagaki et al. 2007, Yang et al. 2018, Dewitz and USGS 2021). We used land cover within the CBC circles from 1992 as our baseline year, which we compared to the grassland/open space area in 2019. We included the pasture/forage crop land cover as grassland based on its similar function for these species in winter. In the Central Valley, pasture is mainly irrigated and forage crops such as hay are usually mowed well before the beginning of the mid-December CBC season. The Carr Fire of 2018 created a data anomaly in the Redding circle, which forced us to use grassland cover data from 2016 for that circle. The 2019 land cover database interpreted the huge burn area as grassland; therefore, the 2016 data gave us much more accurate sense of the actual change in this land cover type. Land cover data for the Stockton circle appeared to suffer from inconsistent interpretations of pasture/hay between the datasets, well beyond any actual changes to the land cover. Therefore, we eliminated the Stockton data from the land cover comparisons.

We also estimated the net loss of grassland for the entire coterminous U.S. (Nakagaki et al. 2007, Yang et al. 2018, Dewitz and USGS 2021) for this same time period. To compare the changes in bird abundance to the change in grassland land cover between 1992 and 2019, we used the bird abundances from Central Valley CBCs based on the values for the earliest and latest years on the 42-year linear trendline for 1992 (Count Year 93) and 2019 (Count Year 120) and compared that decline to the net loss of grassland from the two land cover datasets.

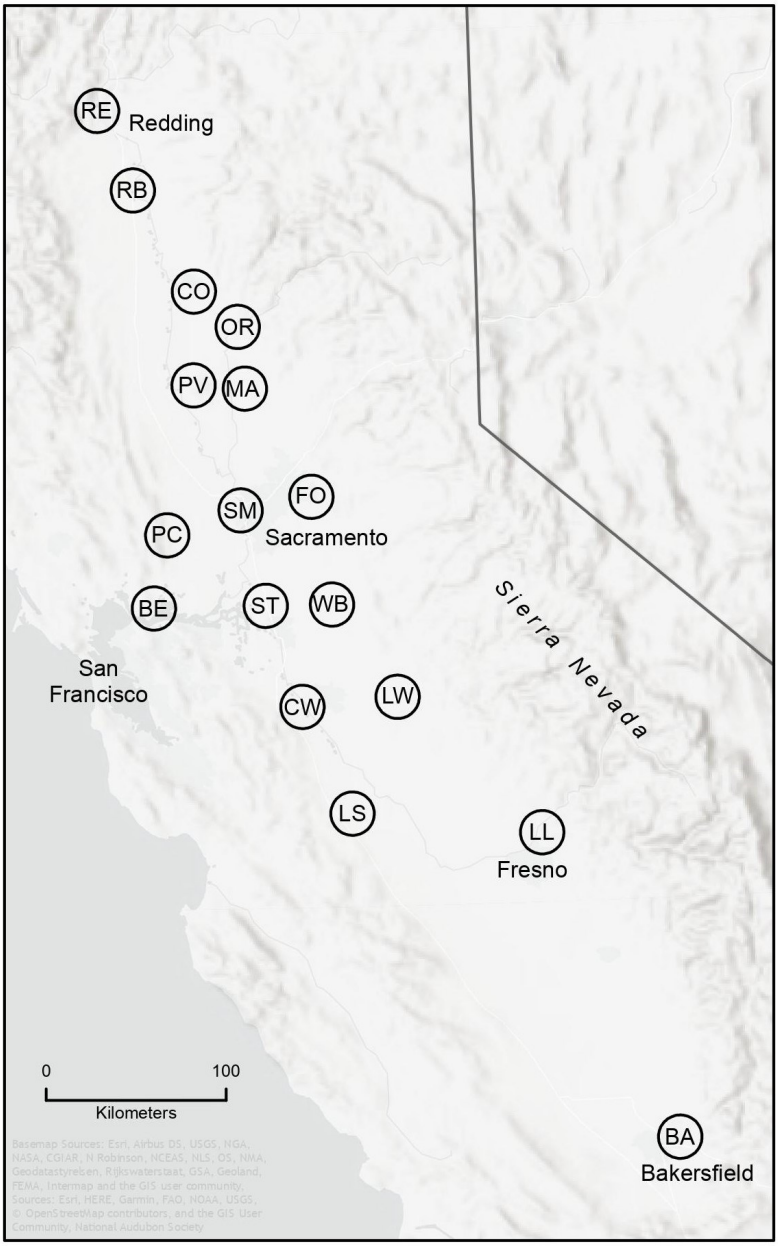

Figure 1. The 17 Central Valley Christmas Bird Count circles used for analysis of population trends. RE, Redding; RB, Red Bluff; CO, Chico; OR, Oroville; PV, Peace Valley; MA, Marysville; FO, Folsom; SM, Sacramento; PC, Putah Creek; BE, Benicia; ST, Stockton; WB, Wallace–Bellota; CW, Caswell–Westley; LW, LaGrange–Waterford; LS, Los Banos; LL, Lost Lake; BA, Bakersfield.

We also used CBC data (National Audubon Society 2020) from the six recent years (2014–2019) to assess the relative importance of the Central Valley to wintering populations of these species. We compared average abundances, based on numbers per party hour, between the 17 Central Valley circles and all North American CBC circles, as well as comparing to abundances within the subset of count circles in the core range of each species (defined as those circles averaging >5 birds/year).

RESULTS

Data from the six additional years (Count Years 115 through 120) suggest that the trends in wintering grassland birds observed by Pandolfino and Handel (2018) for the Central Valley remained largely unchanged. The negative trends for two species, the Loggerhead Shrike and Horned Lark, may even have gotten worse, with abundances on or below the long-term trendline in all six recent years for the shrike, and in five years for the lark (Figure 2). The other four declining species had an equal numbers of recent years in which abundances were above, at, or below the trendline (Figure 3). The Say's Phoebe continued as a grassland species exception, showing a clear increase in abundance in recent years (Figure 4).

Comparing the change in grassland cover in Central Valley CBC circles to the changes in bird abundance between 1992 and 2019 (Table 1) revealed the magnitude of the loss, with all six declining species present at less than half their earlier abundance and grassland land cover decreasing by a smaller, but similar magnitude. During this same period (1992 to 2019), the grassland for the coterminous U.S. also decreased, but to a lesser extent (21% vs. 45% for the Central Valley CBC circles).

Comparing the average abundance of these species on the Central Valley circles to the abundance across all North American CBC circles, and to just those CBC circles within the core ranges of each species (Figure 5), illustrates the relative importance of the Central Valley to these species in winter. The 17 circles within the Central Valley account for a disproportionately large subset of all North American wintering American Kestrels, American Pipits, Lark Sparrows, and Western Meadowlarks. Indeed, approximately one-fifth of all Lark Sparrows and Western Meadowlarks counted within >2,000 CBCs throughout North America were tallied within the 17 Central Valley circles.

DISCUSSION

The continuing decline in grassland-associated bird populations is cause for alarm. The loss of more than half (53%) of the North American grassland-breeding population since 1970 (Rosenberg et al. 2019) is remarkably similar to extent of the decline we documented in six wintering grassland birds in the Central Valley (52–59%) since 1992. Such dramatic, long-term rates of decline,

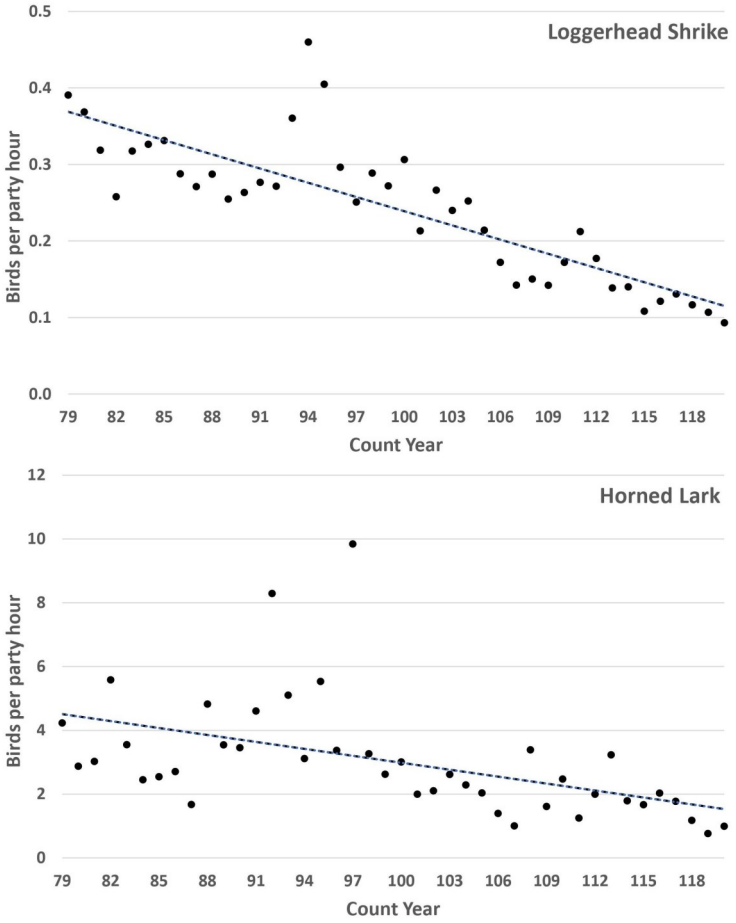

Figure 2. Trends in abundance within 17 Central Valley CBC circles from Count Year 79 (winter 1978–79) through Count Year 120 (winter 2019–20).

coupled with trends that show no sign of improvement, suggest the possibility of regional extirpation of one or more of these species.

Comparing abundance of the declining species in the Central Valley to their abundance throughout North America revealed that this area may be of particular importance in winter, especially to the American Kestrel, American Pipit, Lark Sparrow, and Western Meadowlark. The Central Valley count circles accounted for only 0.7% of all North American circles conducted from 2015 through 2019 but recorded much higher proportions of each of these species (as much as 30-fold higher for the Western Meadowlark). Even when

the comparison was limited to those count circles within the core range of each species, Central Valley abundances for these species exceeded those from other such count circles. The coastal plains of Texas may host higher concentrations of the American Kestrel and similar concentrations of the American Pipit, but no region approaches the Central Valley abundances of the Lark Sparrow or the Western Meadowlark (ERP, unpublished data).

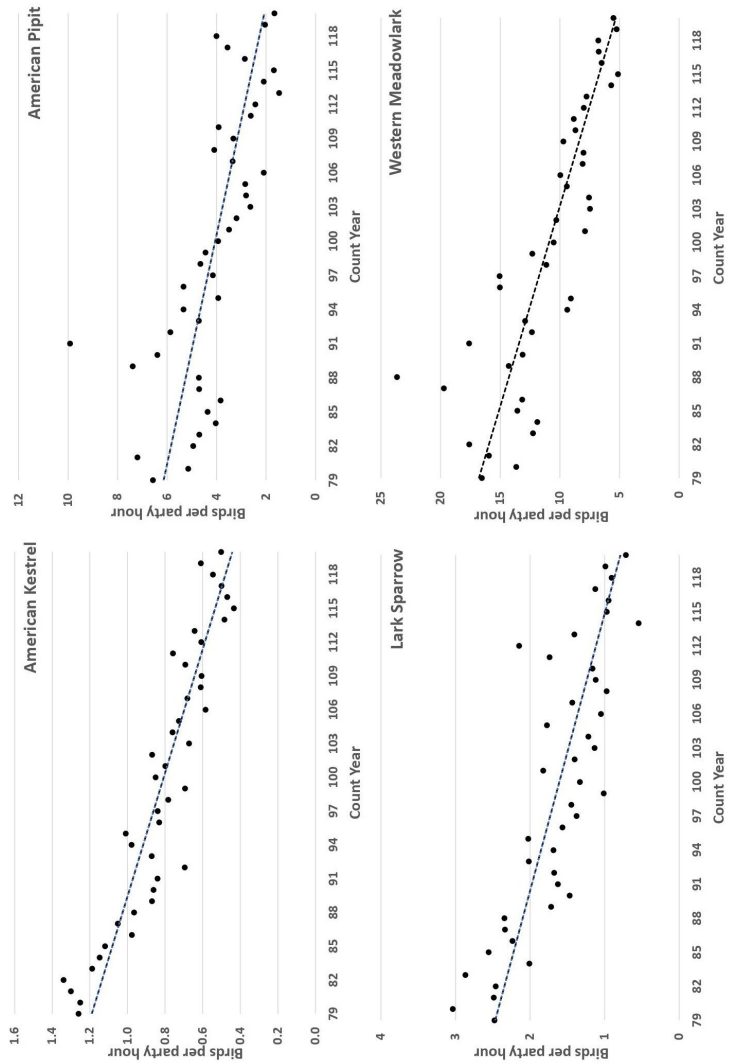

Figure 3. Trends in abundance within 17 Central Valley CBC circles from Count Year 79 (winter 1978–79) through Count Year 120 (winter 2019–20).

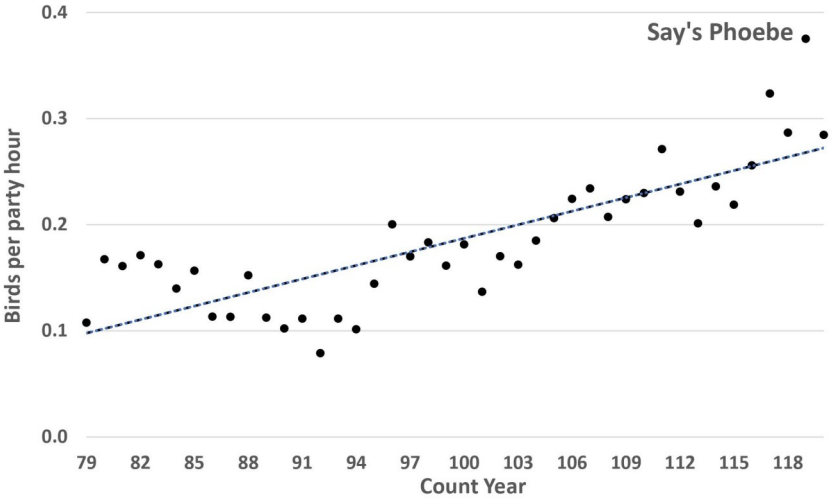

Figure 4. Trends in abundance within 17 Central Valley CBC circles from Count Year 79 (winter 1978–79) through Count Year 120 (winter 2019–20).

Our observation that the declines in grassland bird abundance (52–59%) exceeded the loss of grassland habitat in the Central Valley CBC circles (-45%) suggests that factors other than simple loss of foraging range also may be at play. Fragmentation of remaining habitat may reduce the carrying capacity of an area beyond the effect of net reduction in available habitat. Many grassland bird species demonstrate high degrees of area sensitivity (Ribic et al. 2009). That is, their occupancy or density decrease as the size of the grassland area decreases or as the edge: area ratio increases (which reduces average distance to inappropriate habitats). Of the species we studied here, varying degrees of area sensitivity have been demonstrated in the breeding season for the American Kestrel (Best et al. 1996, Brown et al. 2014), Loggerhead Shrike (Best et al. 1996), Horned Lark (Best et al. 1996), Lark Sparrow (Best et al. 1996, Bolger et al. 1997), and Western Meadowlark (Best et al. 1996, Bolger et al. 1997, Renfrew and Ribic 2002, Bakker 2002, Haroldson et al. 2006). However, some studies did not detect such sensitivity for the Horned Lark (McMaster and Davis 2001, Davis 2004) and Western Meadowlark (Johnson and Igl 2001, McMaster and Davis 2001, Davis 2004). Also, other factors implicated in the continent-wide decline of grassland birds, such as direct and indirect effects of pesticides, may be causing additional impacts beyond those of habitat loss. And, most importantly, we cannot discount the effects of grassland habitat loss within the breeding ranges of these species.

Table 1. Changes in grassland land cover and bird abundance (number of birds counted/party-hour) within Central Valley CBC count circles. The percent change in bird abundance is calculated based on the 42-year linear trendline.

	1992	2019	Change
Grassland (ha)	346,079	190,608	-45%
American Kestrel	0.94	0.45	-52%
Say's Phoebe	0.16	0.28	72%
Loggerhead Shrike	0.28	0.11	-59%
Horned Lark	3.89	1.53	-56%
American Pipit	4.75	2.08	-56%
Lark Sparrow	1.89	0.78	-59%
Western Meadowlark	12.86	5.3	-59%

Given the likelihood that some Central Valley wintering birds also breed here, it is worthwhile to examine the results of a recent Sacramento County Breeding Bird Atlas (Pandolfino et al. 2021) that compared the breeding season status and distribution of some of these same species between two time periods (1988 through 1993 vs. 2016 through 2020). That comparison showed that all of the breeding species that declined during winter also showed reduced breeding distributions within the county (Table 2). The loss of grassland in Sacramento County (-35%) was similar to that we derived for the Central Valley CBC circles (-45%). And, as in our comparison of declines in wintering abundance, the reductions in breeding distribution (as a percent of prior distribution) exceeded the net loss of grassland habitat for each of the species.

Table 2. Changes in grassland area and bird occurrence over two periods surveyed for the Sacramento County Breeding Bird Atlases (Sac BBA). The numbers for each species are the number of atlas blocks with confirmed or probable breeding.

	Sac BBA (1988–93)	Sac BBA (2016–20)	Change
Grassland (ha)	119,090	76,946	-35%
American Kestrel	84	42	-50%
Loggerhead Shrike	60	14	-77%
Horned Lark	33	13	-61%
Lark Sparrow	24	15	-38%
Western Meadowlark	89	40	-55%

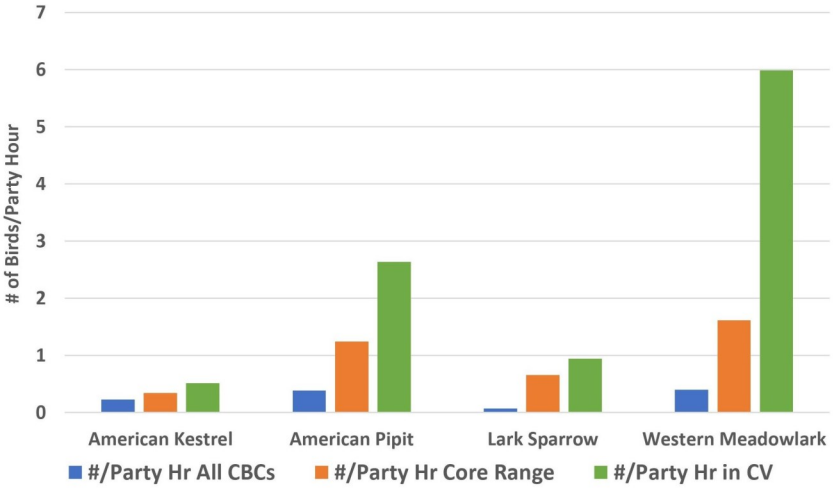

Figure 5. Comparison of the average abundance (birds/party hour) of four species on the 17 Central Valley counts vs. average abundances on all North American CBCs and CBCs within the core range (average >5 birds/year) of each species for Count Year 115 (winter 2014–15) through Count Year 120 (winter 2019–20).

In order to examine the implications of these trends among Central Valley-wintering birds, we considered the life history of each of the species in the context of range wide factors. Five of the declining species (the American Kestrel, Loggerhead Shrike, Horned Lark, Lark Sparrow, and Western Meadowlark) are present in the Central Valley year-round. However, the Central Valley winter abundance of each of those species, based on eBird data (www.eBird.org) and personal observations, is more than double their breeding season abundance. Unfortunately, we do not know if the individuals that breed here also remain though the winter, or if the wintering population comes largely (or entirely) from migrants breeding in other parts of their range. The American Pipit does not breed in the Central Valley and, the Say's Phoebe also did not breed here until the very recent colonization of some areas in the mid-Central Valley (Dunford et al. 2019, Pandolfino et al. 2021, ERP pers. obs.). Below, we consider implications of the observed trends for each of these species.

American Kestrel

The decline in the American Kestrel has received considerable research, with habitat loss, direct and indirect effects of pesticides, and predation by Cooper's Hawks among the causes suggested (Farmer and Smith 2009, Smallwood et al. 2009, McClure et al. 2014). There is disagreement, however, about which factors are most significant (McClure et al. 2014). Although we

do not know if some or all of the wintering kestrels remain to breed in the Central Valley, one study showed that only 9% and 13% of wintering kestrels remained to breed in Tennessee and South Carolina, respectively (Hobson et al. 2009). For the Central Valley kestrels that nest elsewhere, we have little idea of their breeding locations or what impacts they may have experienced there. Banding data suggest that the American Kestrels do not migrate across the Rocky Mountains (Paprocki et al. 2014), so it is likely that wintering Central Valley birds nest somewhere west of there.

Say's Phoebe

Pandolfino and Handel (2018) speculated that the Say's Phoebe's increasing abundance may be due to the significant recent warming of winter temperatures in the Central Valley (see also Pandolfino et al. 2021). As the only obligate insectivore in the group, warmer winters may make more insect prey available for this species. The Say's Phoebe has also been one of very few grassland birds to increase as a breeder in California and throughout its range (Rosenberg et al. 2019, Sauer et al. 2020). This species' success may result from its use of human structures as nest sites (Schukman and Wolf 2019). Indeed, the new breeding locations colonized by Say's Phoebes in the Central Valley have been in sites where development is bordered by open space (Dunford et al. 2019, Pandolfino et al. 2021).

Loggerhead Shrike

The Loggerhead Shrike is the one species of this group for which data suggest that the Central Valley breeders remain through the winter. Band encounter data indicate that most shrikes in the southern parts of their range are resident (Pandolfino 2008). Also, the documented impact of West Nile virus (WNV) on wintering shrike populations coincided with the timing of summer WNV outbreaks (Pandolfino 2008, Smallwood and Nakamoto 2009, Pandolfino 2017). Therefore, it is likely that breeding shrikes remain year-round in the Central Valley, with winter numbers probably supplemented by migrants from other breeding areas. Speculation about the causes of declines include habitat loss, predation, effects of environmental contaminants (Yosef 1996), and susceptibility to WNV (Pandolfino 2008, Smallwood and Nakamoto 2009, Pandolfino 2017). Our observation that the Central Valley CBC abundance for the most recent six years fell below the long-term trendline (Figure 2), coupled with the dramatic contraction of Sacramento County breeding range (77% reduction in breeding blocks, Pandolfino et al. 2021), is cause for great concern. Indeed, this species may be on a path toward extirpation from the Central Valley.

Horned Lark

Two subspecies of the Horned Lark are believed to be largely resident in the Central Valley, *E.a. rubea* in the Sacramento Valley and *E.a. actia* in the

San Joaquin Valley. However, members of as many as five other subspecies may winter in the valley, with some of those taxa difficult to impossible to separate in the field (Beason 2020). Most of those other subspecies breed in northern California or Oregon, but some may come from as far north as southern Alberta. Breeding Bird Survey (BBS) data (Sauer et al. 2020) show significant declines in breeding populations of the Horned Lark throughout California, Oregon and nearly the entire range. Its breeding range within Sacramento County has contracted dramatically since the late 1980s (Pandolfino et al. 2021), second only to the Loggerhead Shrike among grassland birds.

American Pipit

The American Pipit does not breed in California except at few scattered high elevation locations in the highest Sierra Nevada (Hendricks and Verbeek 2020). Its breeding habitat is mainly in arctic tundra and open alpine areas above treeline. Wintering birds in the Central Valley are considered almost exclusively *A.r. pacificus* (not *A.r. articola*, the Sierra Nevada breeder; Grinnell and Miller 1944). *A.r. pacificus* breeds widely across Alaska, western Canada, and some high alpine locations in the Rockies and Cascades ranges (Hendricks and Verbeek 2020). Because BBS roadside survey methodology is not effective for this species, the status of the breeding population in North America is unclear. Climate change is reducing its high alpine habitats as treeline elevations increase (Brunetti et al. 2009, Hendricks and Verbeek 2020) and rapid increases in arctic and sub-arctic temperatures may impact the quality and extent of its northernmost range (Ims et al. 2013, Hendricks and Verbeek 2020). CBC data show a significant decline in American Pipit wintering numbers in the west and non-significant declines in the east (Hendricks and Verbeek 2020). The loss of over half of Central Valley wintering pipits, exceeding the net loss of grassland land cover, suggests that breeding populations may also be declining.

Lark Sparrow

The Central Valley wintering population of the Lark Sparrow is larger than the breeding population (Grinnell and Miller 1944, Pandolfino pers. obs.). However, with only one subspecies, *C.g. strigatus*, found in the west, it is unknown if breeding birds remain for the winter or are partially or completely replaced by individuals from elsewhere. Lark Sparrow breeding numbers in the west appeared to be stable-to-increasing into the early 1990s (Martin and Parrish 2000), but since then declined significantly in California and throughout the western U.S. (Sauer et al. 2020). The breeding range within Sacramento County decreased to a lesser extent than other grassland birds, perhaps due this species' breeding preference for oak savanna, which has not been as severely impacted by development or intense agriculture conversion

as open grasslands (Pandolfino et al. 2021). Although most Lark Sparrows likely winter in Mexico, the winter concentrations in the Central Valley far exceed those of any other U.S. region. Given that this species is mainly a short distance migrant (Martin and Parrish 2000), the Great Basin breeding population may account for most of the Central Valley winterers.

Lark Sparrow (*Chondestes grammacus*).
14 July 2018
Modoc Co., California

Photo by Ed Harper.

Western Meadowlark

Western Meadowlarks winter in the Central Valley in greater concentrations than in any other part of their U.S. non-breeding range, and winter numbers here are at least an order of magnitude higher than breeding season numbers based on eBird data (www.ebird.com; pers. obs.). But, again, we have little information about the source of wintering birds. Given the ability of this species to make very long migrations (Davis and Lanyon 2008), some of these birds could come from as far as the northern Great Plains. The substantial contraction of the meadowlark's breeding range in Sacramento County is largely attributed to the conversion of grasslands to vineyards and row crops in the southern parts of that county (Pandolfino et al. 2021). BBS data showed significant long-term declines throughout its breeding range, with negative trends particularly high at the eastern edge of the breeding range (Sauer et al. 2020).

Western Meadowlark (*Sturnella neglecta*).
5 April 2021.
Butte Mountain Rd., Tehama Co., California.

Photo by Michele Swartout.

Conclusions

The significant long-term declines in the Central Valley wintering populations of the American Kestrel, Loggerhead Shrike, Horned Lark, American Pipit, Lark Sparrow, and Western Meadowlark observed by Pandolfino and Handel (2018) appear to have continued during the succeeding six years. The rate of decline may have increased for the shrike and the lark. The Say's Phoebe numbers continued to increase, and that species has even begun to breed in several locations at the southern end of the Sacramento Valley. The net loss in abundance we estimated for each of the declining species (52 to 59%) exceeds the net loss of grassland in the Central Valley CBC circles (45%) during that same period (1992 to 2019). The North American breeding populations of the American Kestrel, Loggerhead Shrike, Horned Lark, Lark Sparrow, and Western Meadowlark all showed significant declines, and the Say's Phoebe breeding numbers have increased significantly (Rosenberg et al. 2019, Sauer et al. 2020). The continued loss of Central Valley grassland habitat is of particular concern for the Lark Sparrow and Western Meadowlark, since this area appears to host much higher winter abundances of these species than any other part of their winter range.

Migratory birds spend more of their year within the non-breeding range than on their breeding grounds (Newton 2008). Without sufficient high-quality winter habitat, these species cannot survive. Central Valley grasslands, arguably the most important North American wintering area for several grassland species, are being converted at an alarming rate to uses incompatible with the needs of these birds.

The continued long-term decline of grassland birds and their habitat demonstrates the strong need for expanding conservation efforts in California. Several counties have completed or are currently developing large scale conservation plans such as Habitat Conservation Plans (HCP) or Natural Community Conservation Plans (NCCP) and each of these efforts offer opportunities for the public to provide input. These programs provide the best chance to permanently preserve large areas of habitat needed by most grassland birds. Incorporating good scientific information, "adaptive management" (i.e., a built-in process for updating the plan as new scientific information and plan effectiveness results become available), and advocacy for grassland protection at a landscape scale are critical to the success of these plans.

While such plans can help conserve some of this resource by guiding development, much of the grassland conversions in California have been from cattle ranches to orchards or vineyards (Cameron et al. 2014, DiGaudio et al. 2017. Hammond et al. 2022), which are not subject to regulatory approval. Thus, the fate of our grassland birds is mainly dependent on maintaining

cattle ranching as an economically viable land use. Two organizations focused on keeping ranching viable in the state are the California Rangeland Trust (https://rangelandtrust.org/) and the California Rangeland Conservation Coalition (https://carangeland.org/). Public support for these and other land trusts and conservation organizations and shopping at stores that carry products from "bird-friendly" ranches and farms (see https://www.audubon.org/where-buy-products-raised-audubon-certified-lands) are helpful. Despite declines, the Central Valley still hosts large numbers of wintering grassland birds, and it is not too late to save the resources they need.

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