Breeding Status of the Tricolored Blackbird in the Foothill Grasslands of the Sierra Nevada, California, in 2017

Peer-Reviewed Paper

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ABSTRACT

We report on Tricolored Blackbirds (*Agelaius tricolor*) breeding in 2017 in grassland-dominated east side of the Central Valley and lower foothills of the western Sierra Nevada, California. We identified 1,553 km^2 (600 mi^2) of suitable Tricolored Blackbird habitat in the 4,169 km^2 (1,610 mi^2) study area and surveyed 25% of this area. Regionally, rainfall was nearly double that of both 2016 and the 20-year average. We identified 37 active Tricolored Blackbird colonies supporting 72,800 breeders. The number of breeders recorded in 2017 was 6.5% less than in 2016, likely attributable to a reduction in survey area by one third. The number of breeding birds increased by 26% from 2016 within the central foothills subregion, which supports over three fourths of the total breeding population in the foothill region. Breeders in the southern foothills declined by a third (to 15,030) from 2016. Nearly three-fourths of colonies and nesting birds regionwide nested in non-native Himalayan blackberry (*Rubus armeniacus*), followed by

emergent wetlands (31% of colonies and 20% of nesting birds). Regional differences in nesting substrate use likely reflected different substrate availabilities. In the southern foothills, most 2017 nesting was in emergent wetlands, in contrast to predominant use of milk thistle (*Silybum marianum*) in 2016. Thistle was much less abundant in the region in 2017 than in 2016, despite increased rainfall. All 34 colonies monitored through the nestling stage fledged young. Predation occurred only at two southern foothill colonies in emergent wetlands, where water level declines allowed access to mammalian predators, but successful renesting occurred in areas of deeper water. No active 2017 colonies were disrupted by human activity, but development and mining threaten five Sacramento County colony sites that supported 17,500 breeders (24% of the 2017 regional total). Continued conservation needs include land protection, maintenance of existing grazing land uses, and creation of stable nesting habitat in the southern foothills.

INTRODUCTION

The Tricolored Blackbird (*Agelaius tricolor*) has declined in California over recent decades with primary causes suggested as habitat loss and destruction of breeding colonies during agricultural operations (Cook and Toft 2005; Meese 2015, 2017; Beedy et al. 2017). The species is currently a candidate for listing under the California Endangered Species Act and is under formal review under the federal Endangered Species Act.

Previously, we reported on surveys conducted in 2014, 2015 and 2016 to characterize Tricolored Blackbird breeding status and habitat within the grassland-dominated region that includes the east side of the Central Valley and lower foothills of the western Sierra Nevada (hereafter "foothills"; Airola et al. 2015a, b; 2016). Surveys in 2014 and 2015 occurred under drought conditions, whereas precipitation in 2016 was average-to above-average (see RESULTS). The number of breeding birds we recorded varied from about 43,000 in 2014 to 77,830 in 2016, partly as a result of differences in area surveyed and variation in nesting habitat conditions in the southern foothills. Comparison of different subregions surveyed during the 2015 drought and in 2016 during average rainfall year showed a decrease in breeding in the Central Sierra foothills and an increase in the southern foothills, likely associated with the an substantial increase in the amount of milk thistle (*Silybum marianum*)(Airola et al. 2016).

Nesting in 2014-2015 occurred primarily in upland patches of the non-native Himalayan blackberry (*Rubus armeniacus*) and to a lesser extent in ponds supporting cattail (*Typha latifolia*) and tule or bulrush (*Schoenoplectus acutus* var. *occidentalis*) within the Central Sierra region. In 2016, blackbirds continued to nest in these substrates in the central foothills, but most of the

22,460 breeding birds in the southern foothills in 2016 were in milk thistle (Airola et al. 2016).

In this 2017 study, in a year of above average rainfall, we estimated the number, sizes, and success of Tricolored Blackbird breeding colonies in the northern, central, and southern portion of the Sierra Nevada foothill grasslands. Study objectives were to:

- estimate the extent of the breeding use of grassland-dominated area,
- evaluate survey coverage, to determine the potential for occurrence of undetected colonies;
- compare numbers of breeding birds observed in 2017 to numbers detected in previous years within the Sierra foothills as a whole, and in three subregions;
- document fates of colonies and estimate the proportion that produced young;
- assess use of nesting substrates and colony site use fidelity;
- document any observed land-use conflicts with active colonies; and
- compare numbers we observed during 2014 and 2017 to numbers recorded in this region during the Statewide Tricolored Blackbird Survey (Meese 2015, 2017).

A particular interest to us was to compare numbers and nesting habitat and habits in the southern foothills in 2017 with previous years, considering the dramatic changes that occurred previously between the 2015 drought year and the 2016 average precipitation year (Airola et al 2016).

The Statewide Survey has been conducted in California triennially in early April since 1994 to assess the species' statewide population status and trends (Meese 2015). The three-day survey occurs during early April, the early portion of the species breeding season, when most of the population is in the southern portion of its range. Due to its early timing, the Statewide Survey results would seem to provide a more accurate indication of breeding status in southern portions of the species range and would be less accurate in characterizing breeding status in northern areas where breeding begins later. Despite widespread recognition of survey limitations, the Statewide Survey has been used extensively to characterize the species' status in northern portions of the range (Meese 2014, 2015, 2017). The availability of our comprehensive breeding colony estimates for the foothill grasslands during 2014 and 2017 provides an opportunity to compare numbers of birds recorded during the Statewide Survey with the number of breeders that ultimately bred in this region. We conduct this comparison to evaluate the utility of Statewide Survey results as indicators of breeding population size in the foothills.

STUDY AREA

The 2017 study area consisted of much of the area we surveyed in 2016 (Airola et al. 2016) that included lands at 15 to 550 m elevation dominated by annual grasslands in the lower foothills of the western Sierra Nevada and the eastern edge of the Central Valley, California. The area included portions of 13 counties, from Yuba in the north to Fresno in the south (Figure 1). The study area included 167 km^2 (64 mi^2) in the Yuba County portion of the region previously designated as *the northern foothills*, but did not include lands in Tehama, Butte, and Sutter counties surveyed in 2016. The 2017 *central foothills* study region included the same areas surveyed since 2014 in Placer, El Dorado, Sacramento, Amador, San Joaquin, Calaveras, and Stanislaus counties. The *southern foothills* included lands in Tuolumne, Merced, Mariposa, Madera, and Fresno counties also surveyed in 2016 and partially in 2015 (Airola et al. 2016). Surveys were conducted in areas accessible by public roads (see METHODS and RESULTS for details).

As previously, the term *survey area* refers to areas of suitable habitat within the study area and subregions that were surveyed during the study (see METHODS). We identify individual colony locations in italics, using location names in the Tricolored Blackbird Portal (http://tricolor.ice.ucdavis.edu).

METHODS

Study methods in 2017 were mostly the same as those of previous years (Airola 2015a, b; 2016). We briefly summarize methods, with emphasis on any changes that occurred in 2017.

We summarized rainfall using data from 17 weather stations in the study area, at elevations of 8 to 500 m in the north (Chico University Farm), central (Auburn, Auburn Dam Ridge, Sacramento WB City, Folsom Dam–Folsom Point, Folsom Lake, Perry Ranch, Camp Pardee, New Melones, Modesto Irrigation District) and southern foothills (New Melones Reservoir, Moccasin, New Exchequer-Lk McClure, Merced, Madera, Fresno WB Airport, Pine Flat Dam; http://cdec.water.ca.gov/). We quantified rainfall for the October 2016–June 2017 ("*2017 water year*") and compared it to previous years and the 20-year average. We modified the previous water year definition to extend it to June because more rain fell during this portion of the nesting season than in previous years.

Experienced observers (mostly the authors) surveyed for breeding birds from 1 April to 23 June in 2017 (Figure 1; Table 1). Surveyors initially visited all previously known colony sites during 6-9 April, as part of the 2017 Tricolored Blackbird Statewide Survey (Meese 2017). We then conducted repeated road-based surveys for breeding colonies within a large area of suitable grassland and irrigated pasture land covers. We also surveyed any sites where observers

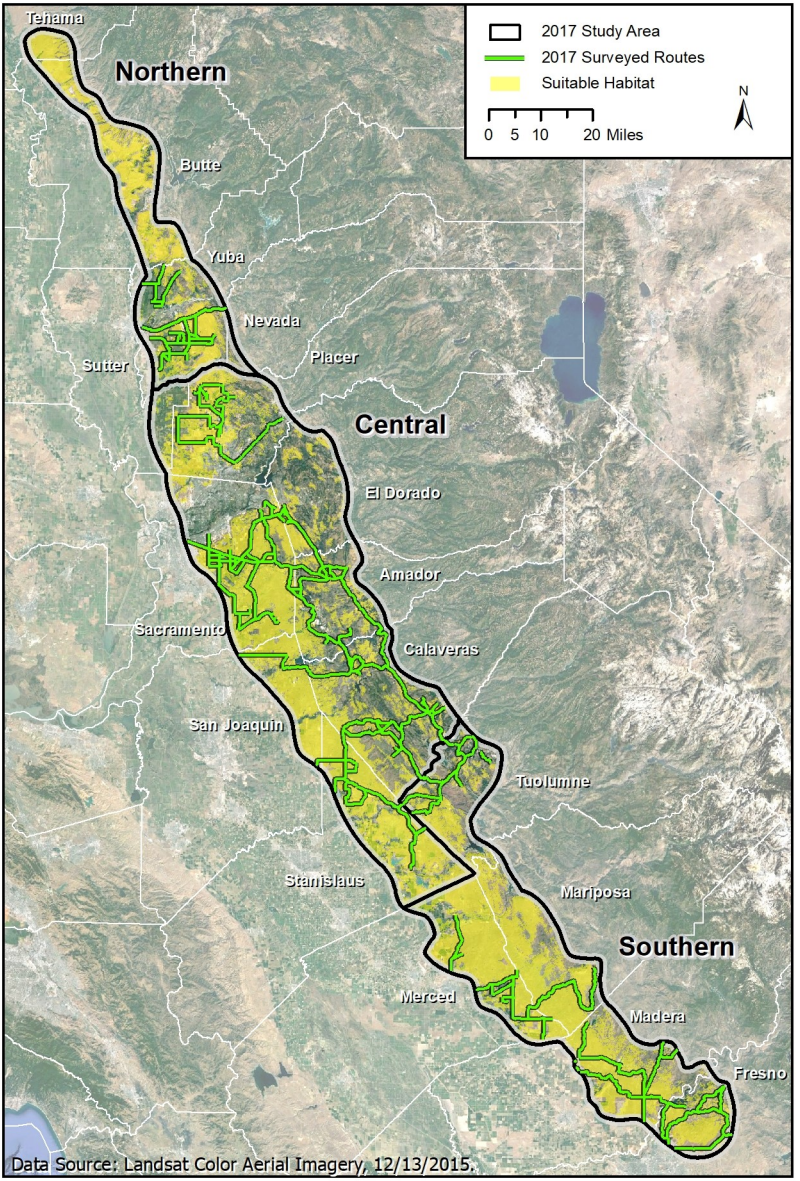

Figure 1. 2017 Tricolored Blackbird breeding survey study area and survey routes within the suitable habitat in the northern, central, and southern regions of the Sierra Nevada foothills.

reported Tricolored Blackbird colonies or concentrations over the 2017 nesting season in eBird (http://ebird.org/ebird/map/).

Table 1. Suitable Tricolored Blackbird habitat surveyed during 2015-2017 Breeding Surveys in the foothill grassland study area, California. Suitable habitat is defined as extensive areas of grassland and irrigated pasture lands visible within 1.6 km of survey routes.

		Suitable Habitat Surveyed (km^2)		
Sub-region	County	2015	2016	2017
North	Tehama		31	
	Butte		200	
	Yuba	30	185	167
	Sutter		11	
	Subtotal	*30*	*427*	*167*
Central	Placer	183	214	195
	El Dorado	20	33	22
	Sacramento	424	506	350
	Amador	63	96	64
	San Joaquin	64	103	64
	Calaveras	99	135	95
	Stanislaus	169	235	168
	Subtotal	*1,022*	*1,321*	*957*
South	Tuolumne	42	58	43
	Mariposa	94	175	41
	Merced	69	222	158
	Madera		141	143
	Fresno		57	43
	Subtotal	*205*	*653*	*429*
	Total	**1,257**	**2,401**	**1,553**

We estimate and report the numbers of actively breeding birds (i.e., those that reached the incubation stage). For colony estimates, we mostly (92% of colonies) used counts from the later nesting stages (i.e., when nestlings were being fed or fledglings were present). At remaining colonies where we were unable to return to monitor late nesting stages, we used counts from the incubation stage (which may have underestimated numbers; Beedy et al. 2017). Two colonies found at the pre-nesting stage were not surveyed later to determine whether they became active. Therefore, these numbers were not included in survey totals.

For the 2016 survey, we quantified nesting activity as the number of *breeding attempts*, not breeding birds because spring rainstorms appeared to cause substantial nesting failure and apparent renesting attempts (Airola et al. 2017) by the same individuals. In 2017, low levels of nest failure during the mid- to-late nesting period reduced potential for renesting. Therefore, for the 2017 survey we have reverted to use the previous term breeding birds (Airola et al 2015, 2016) as the basis for quantifying the nesting population. We compare breeding density, (i.e., number of breeding birds per area of suitable habitat surveyed) in each subregion and county and compare numbers of breeders with numbers in previous years in areas of similar survey coverage.

We attempted to determine nesting stage during each colony survey (see Airola 2015a,b) and characterized each site during each visit as *occupied* (breeding groups present in suitable habitat), *active* (colony reached egg-laying stage), or *successful* (fledglings observed). Occupied sites that did not become active are referred to as *abandoned*. Sites that became active but did not produce young were considered *failed*. We characterize *colony reproductive success* as the proportion of colonies that were successful (i.e., fledged at least some young). As previously, if we did not visit a colony during the fledgling period, we considered all colonies with adults that were feeding nestlings to have fledged at least some young, and therefore considered these colonies successful.

Suitable habitat was identified and surveyed as previously described (Airola et al. 2016) as areas with extensive grassland, pasture, and dryland-farmed grain that serves as foraging habitat. Designation did not consider availability of suitable nesting habitat because of its distribution in small patches (many <0.1 hectare [0.25 ac]; D. Airola, unpub. data) made mapping impractical. We evaluated the proportion of suitable habitat that was surveyed within the entire study area and within each subregion. We mapped visible areas of suitable habitat within 1.6 km (1 mi) of survey routes as surveyed (i.e., not obstructed by vegetation or topography) using Esri's ArcGIS 10.2 3D Analyst Viewshed (see Airola et al 2015b, 2016). We used the area of suitable habitat surveyed in each county and subregion to calculate breeding density (number of breeding birds per km^2 of habitat) to adjust for different amounts of habitat surveyed in various areas.

We recorded the vegetation used for nesting at each colony and compared patterns among years. We evaluated colony site fidelity in two ways. First, we determined which of the active 2017 colony sites that had been surveyed in 2016 were active in one or both years. Second, we assessed colony activity for all 106 sites that were active and surveyed in at least one year over the 4-year study, based on the number of years of occupancy out of all available years of survey (i.e., survey-years). We also noted any loss of nest sites from previous years due to land use changes and documented the use of sites known to have been subject to past disturbance.

To evaluate the accuracy of the Statewide Survey in characterizing the size of the breeding population in the foothill grassland region, we compared the statewide survey totals and our breeding survey totals in both 2014 and 2017. The boundaries of our central foothill region and the Statewide Survey's "Sierra foothills region" (Meese 2014) differed slightly. To ensure comparability, we used totals within the same set of five central foothill counties where all nesting colonies occurred in foothill grassland areas and where data were available in both years: Placer, Sacramento, El Dorado, Amador, and Calaveras.

RESULTS

Precipitation

Precipitation in the study area and all subregions during the 2017 water year was substantially greater than in previous study years and the 20-year average (Figure 2). Totals for the 2017 study area increased by 98% from 2016 and 93% from the average.

Survey Coverage

Surveys in 2017 covered 1,550 km (962 mi) of roads in the foothill study area, many of which were driven multiple times during the nesting season. We identified 6,154 km^2 (2,375 mi^2) of suitable habitat in the boundaries of the entire 11,517 km^2 (4,450 mi^2) study area, of which 6% was in the northern foothills, 55% in the central foothills and 39% was in the south (Table 1, Figure 1). Based on analysis of visibility from roadways, we surveyed 1,553 km^2 (600 mi^2) in 2017, which represents 25% of all suitable habitat in the entire study area. The proportions of suitable habitat surveyed by subregion were 47% in the north, 28% in the central, and 18% in the southern foothills (Table 1). By region, 11% of the total surveyed area was in the northern foothills, 62% in the central foothills, and 28% in the southern foothills.

The total land area surveyed in 2017 was 35% lower than in 2016, but 23% higher than in 2015 (Table 1). By subregion, survey areas decreased between 2016 and 2017 in the northern, central, and southern subregions by 61%, 27%, and 34%, respectively. Some of this decline was due to lack of surveyors (i.e., Butte County). In other cases, we excluded areas that consistently did not support nesting colonies in previous years, such as Mariposa County and certain parts of the central foothills that lacked suitable nesting habitat.

Observed Breeding Population and Density

We observed an estimated total of 72,800 breeding Tricolored Blackbirds at 37 active colonies in the foothills in 2017 (Table 2). The number of colonies recorded in 2017 declined from 2016, likely due in part to two factors. Survey area was reduced in the northern foothills (i.e., lack of surveys in Butte County) and nesting habitat in foothill portions of Merced County was mostly

absent, due to lack of milk thistle. The total number of colonies in the central foothills (25-29) remained remarkably similar over 2014-17.

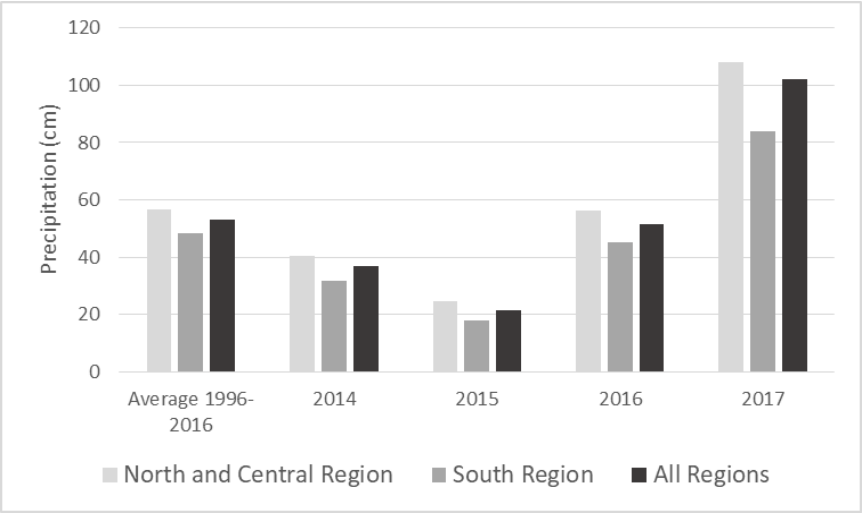

Figure 2. Annual precipitation prior to and during the nesting season (October-June) in foothill subregions, 2014 to 2017, compared to the 21-year average.

The number of breeding birds recorded in the foothills as a whole was 6.5% lower than the 77,830 breeding birds recorded in 2016, but substantially higher than the numbers recorded in 2014 and 2015 (Table 2). The 72,800 breeders in the 2017 study areas is nearly identical to the 73,900 birds recorded in the same counties in 2016 (i.e., excluding Butte County; Table 2).

Breeding density (no. breeders/suitable habitat surveyed) in the entire study area increased from that of 2016, to a level slightly higher than in 2015 (Table 2), despite lower survey intensity in 2017.

Northern Foothills Region. We recorded only one colony and 1,000 breeding birds in the northern foothills in 2017, numbers that were substantially lower than in 2016. Density in the surveyed portion of the northern region also decreased to 2015 levels (Table 2). Although the decline is partly attributable to reduction in survey area (including exclusion of Butte and Tehama counties in 2017), numbers also declined in Yuba County (Table 2) where survey effort was similar to 2016.

Central Foothills Region. We recorded an estimated 56,770 breeding birds (78% of the foothill total) at 27 nesting colonies in the central Sierra foothill

Table 2. Numbers of Tricolored Blackbird nesting colonies, breeding birds, and breeding density by county and sub-region in the foothill grassland study area, California, 2014-2017.

		Number of Active Colonies				Number of Breeding Birds[1]				Density (Breeding Birds/ Km^2)		
Sub-region	County	2014	2015	2016	2017	2014	2015	2016	2017	2015	2016	2017
North	Butte			7				3,930			20	
	Yuba		1	5	1		200	6,400	1,000	7	35	6
	Subtotal		*1*	*12*	*1*		*200*	*10,330*	*1,000*	*7*	*24*	*6*
Central	Placer	6	5	7	6	12,473	19,200	19,900	9,750	105	93	50
	El Dorado	4	1	1	0	5,800	2,900	1,000	0	145	31	0
	Sacramento	9	12	7	9	11,000	19,300	17,150	33,800	46	34	97
	Amador	3	4	3	5	6,375	6,320	1,140	1,500	100	12	23
	San Joaquin	0	0	0	0	0	0	0	0	0	0	0
	Calaveras	3	2	3	4	760	350	1,300	720	4	10	8
	Stanislaus	4	1	4	3	6,601	7,000	4,550	11,000	41	19	66
	Subtotal	*29*	*25*	*25*	*27*	*43,009*	*55,070*	*45,040*	*56,770*	*54*	*34*	*59*
South	Tuolumne	0	0	2	4	0	0	2,300	1,140	0	40	27
	Mariposa		0	0	0		0	0	0	0	0	0
	Merced		0	7	2		0	10,950	3,750	0	49	24
	Madera			3	3			7,110	10,140		50	71
	Fresno			1	0			2,100	0		37	0
	Subtotal	*0*	*0*	*13*	*9*	*0*	*0*	*22,460*	*15,030*	*0*	*34*	*35*
	Total	**29**	**26**	**50**	**37**	**43,009**	**55,270**	**77,830**	**72,800**	**44**	**32**	**47**

[1]Zeros indicate surveyed areas where no colonies were found.

region (Table 2). Sacramento County supported 33,800 nesting birds, the largest number (59%) of any county in the region. Numbers in Placer and Stanislaus counties were close to or exceeded 10,000, while ≤1500 were in Amador and Calaveras counties. No breeding birds were found in El Dorado or San Joaquin counties.

Numbers in the central foothills increased by about 26% from 2016, despite a 28% decline in survey coverage (Table 2). Overall, numbers of colonies and breeders in the central foothills have remained relatively stable over 2014-2017, despite variation in survey effort (Table 1). Numbers and density in Sacramento County were substantially above those recorded in 2014-2016, whereas the population and density in adjacent Placer County declined by about half from the number recorded in 2015-2016 (Table 2). Together, breeding birds within these two counties, which support the majority of the nesting population in this region, increased by 17% from 2016. Major concentrations located in Sacramento County included the *Elder Creek 1, 2, 4,* and *7* colonies, which supported 13,500 nesting birds within a 135-ha (330 ac) area and 9,300 breeders at the *Silva Ranch* colony, a previously unsurveyed site. A group of 7,500 also nested in northern Stanislaus County at the *Sonora Rd at Littlejohn Creek* colony.

Southern Foothills Region. We detected just over 15,000 breeding birds at seven colonies in the southern Sierra foothills (Table 1). Tuolumne County had the most colonies with four, but each was small, supporting only 40-500 birds. Other colonies included one in Merced and three in Madera County, while no colonies were detected in foothill portions of Mariposa and Fresno counties. Two colonies in Madera County attracted large numbers of nest-building birds. At the *Merced Equalization Reservoir #1* site, about 10,000 birds began nesting in a cattail and tule patch that developed in 2017 at a previously unoccupied site (Figure 3). A substantial (but unquantified) number of nests failed during incubation, however, due to falling water depth and resulting predation by raccoons (*Procyon lotor*), but many birds re-nested in a more deeply flooded portion of this site. Blackbirds at the *Madera Canal Tules #1* that numbered 6,000 during settling and 3,000 during incubation also suffered substantial mammalian predation which resulted in only about 30 nests fledging young (Swarth et al. 2017).

Total breeding birds in 2017 declined in the southern foothills from 2016 (Table 2). We recorded 31% fewer nesting colonies and a decline by 33% in breeders in 2017 compared to 2016. Madera County supported the highest numbers of breeders in the southern region, with two-thirds of the regional total and 14% of the population in the total foothill study area. Numbers of breeders in Merced County decreased by 66%.

Breeding density in the southern foothills in 2017 remained similar to that in 2016, despite a decline in number of breeding birds. Lack of decline in

density primarily reflects the reduced 2017 survey effort in Mariposa County (Table 1), where no colonies have been located during surveys in 2015-2017. Densities declined in all southern counties except Madera. Breeding density in Madera County was the highest of counties in the southern foothill subregion and second highest among all counties.

Figure 3. Tricolored Blackbird feeding flock, estimated at 1,800 birds, at the *Merced Equalization Reservoir #1* colony site, Madera County, California, 2017. *Photo by Gary Woods.*

Nesting Colony Success

All 34 colonies monitored for reproductive success fledged at least some young. Overall, we identified 53 sites occupied by Tricolored Blackbirds in the 2017 foothill study. Thirty-seven sites (70%) were verified as supporting active colonies (Table 2). Five sites were documented to have been abandoned after nesting building and apparently before egg-laying, whereas another 10 were considered likely to have been abandoned before egg-laying. Monitoring at one site (*Pond at Campo Seco and Waterton* in Calaveras County) was insufficient to determine its fate. At the 37 active colonies, the latest nesting stages we verified were: fledging young at 15 colonies, feeding young at 19 colonies, and incubating at three colonies. Success was concluded for the 34 colonies observed at or after the nestling stage based on 2017 and previous years' results showing that some young fledged from over 95% of colonies where adults had been observed earlier bringing food to young.

Despite very high rainfall in 2017, we recorded no colony failures or abandonment attributable to severe storm events. One colony in milk thistle, *Triangle Rock Products 4* (Sacramento County), was abandoned shortly after nest-building as thistles dried out and died. Predation substantially reduced nesting success at several southern foothill colonies (*Madera Tules #1 and Madera Equalization Reservoir #1, Madera County*) in emergent wetlands, apparently facilitated by decreased water levels as the season progressed, which allowed easier access by raccoons and other ground predators.

Nesting Substrate

Nesting substrate use in 2017 was similar to that of previous years (Figure 4), except in the southern foothills. Himalayan blackberry continued as the predominant nesting substrate. It was used at 27 active colonies (75% of total) and by 74% of the total active breeding population. It was the sole nesting substrate at 23 colonies (64%) that supported 67% of the total population. Emergent wetland vegetation (cattail and tule) continued as a subdominant nesting substrate, used at 10 sites (37%) and by 20% of the breeding population. Wetland vegetation was the sole nesting substrate at 7 sites (19%) used by 19% of all breeding birds. Willow (*Salix* sp.) was used with emergent wetland at one site (*Papoose Pond*, Amador County). Non-native sweetbriar rose (*Rosa rubiginosa*) was used for the first time over the four years of foothill study at one colony (*Elder Creek #4*), where a small group of blackbirds settled after adjacent Himalayan blackberry habitat was apparently saturated with nesting pairs.

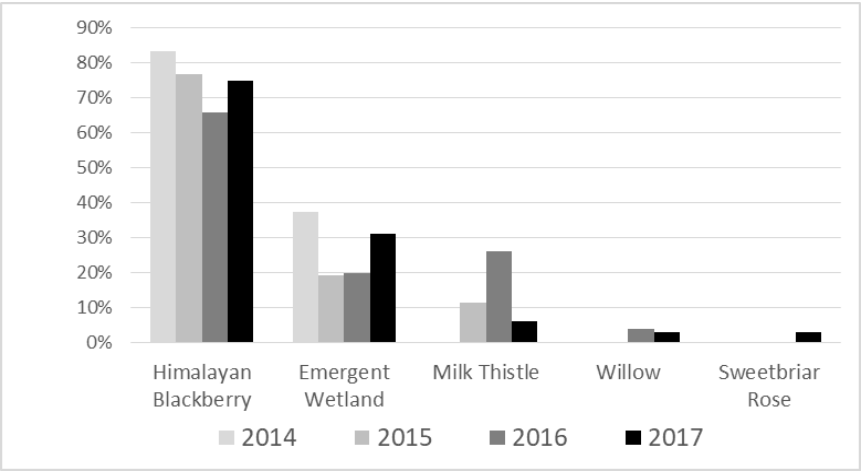

Figure 4. Use of nesting substrates at Tricolored Blackbird colonies in the Sierra Nevada foothill grasslands in 2014-2017. Percentages do not add to 100 in each year because multiple substrates were used at some sites.

As in previous years, Himalayan blackberry was the predominant nesting substrate in the central and northern foothills, used at colony sites supporting 88% of nesting birds. In the southern foothills, emergent cattails and tules, which grew in denser and taller stands presumably as a result of increased precipitation (C. Swarth, pers. obs.), were the primary nesting substrates, used at five colonies (56%) that supported 73% of nesting birds; only 27% of birds there nested at blackberry sites. In stark contrast to 2016, no birds nested in milk thistle in the southern foothills in 2017.

Colony Site Fidelity

Thirty-four of the 37 sites that supported active colonies in 2017 were also surveyed in 2016. Three 2017 colony sites (8%) were at sites that had not been surveyed previously. Of the 34 sites occupied in 2017 that were also surveyed in 2016, 18 (53%) were occupied and 16 (47%) were not occupied in 2016. In the southern Sierra foothills, eight active 2017 colonies also were at sites surveyed in 2016. Two sites were active in both years, while six were in areas previously surveyed and found to be unoccupied. One active 2017 site in the south was unsurveyed during 2016.

Over the 2014-2017 study period, 65 sites were active in at least one year and surveyed in at least three years. Of these sites, 42 (65%) were active only in one year; 13 (20%) were active in two years; and 10 sites (15%) were active in three or four years. We also assessed colony activity among all 106 sites that were active and surveyed in at least one year. In total, sites were active during 36% of survey-years (127 of 351 survey-years).

Human-caused Nesting Habitat Disturbances

Habitat Removal. Several breeding sites used in 2014-2016 were disturbed prior to the 2017 nesting season. The *Bear Creek Road* site (Merced County) supported a large colony (7,000 birds) in milk thistle in 2016. By March 2017, all the thistle there had been removed (Swarth pers. obs.). Substantial maintenance and rebuilding that removed much of the emergent vegetation were conducted during the winter of 2016-17 at *Hunt Rd #2* pond (Calaveras County), but emergent vegetation regrew and supported a small colony of 200 birds.

Aggregate mining activities were initiated after the end of 2017 nesting season near Elder Creek Rd. (Sacramento County). This 135-ha (330 ac) area of irrigated pasture had supported 13,500 nesting birds in 2017 at four colonies (*Elder Creek 1, 2, 4, 7).* The area has consistently supported the densest concentration of nesting Tricolored Blackbirds in Sacramento County and the foothills as a whole over 2014-2017 (see Figure 2 in Airola et al. 2016). In preparation for mining, irrigation was discontinued, and as a result the copses of Himalayan blackberries where birds nested died back. Additional clumps of blackberry that have been used for nesting in the past, however, occur outside of the mining area just south of Elder Creek Rd.

Development Adjacent to Colonies. Following commercial development in 2016 of the site immediately adjacent to the *Iron Point Road* colony (Folsom, Sacramento County) approximately 4,000 blackbirds returned and fledged many (but an unquantified number of) young in 2017. Unfortunately, an estimated minimum of 200 blackbirds were killed by striking windows at the newly constructed fitness center near the colony site before netting was installed to reduce collisions (J. Brown, pers. comm.). Additional lands immediately northeast of the colony also were being developed as of September 2017. Of greater long-term concern is the nearby Folsom Ranch development which will eliminate a large area of grasslands where birds have foraged annually since 2015. Initial construction of 93 ha (230 acres) began during the 2017 nesting season (Figure 5).

Figure 5. New construction at the Folsom Ranch development, south of Interstate 50 in Folsom, California, May 2017. This area has been a major foraging area for the Iron Point Road Tricolored Blackbird colony, which is located near the development in the distant background, and several other nearby colonies.

Comparison of Statewide Survey and Breeding Status Results

The numbers of Tricolored Blackbirds counted in 2014 and 2017 on the triennial April Statewide Surveys differed substantially and inconsistently from the number of breeders recorded over the entire season during the foothill breeding surveys in those years (Table 3). In 2014, the Statewide Survey total for the five foothill counties was nearly 50% higher then the numbers recorded in the foothill breeding survey. In 2017, however, Statewide Survey numbers were only a third of the foothill breeding survey (Table 3).

Table 3. Comparison of numbers of Tricolored Blackbirds recorded during 2014 and 2017 in the Statewide Survey and the foothill breeding survey.

	2014		2017	
County	Statewide Survey	Foothill Breeding Survey	Statewide Survey	Foothill Breeding Survey
Placer	17,600	12,473	960	9,750
El Dorado	1,375	5,800	100	0
Sacramento	29,272	11,000	12,455	33,800
Amador	5,500	6,375	420	1,500
Calaveras	404	760	1570	720
Total	**54,151**	**36,408**	**15,505**	**45,707**

DISCUSSION

Observed Nesting Population

The similarity of the breeding populations in the foothill region during 2016 and 2017 attests to general stability of the population in the foothills as a whole during periods of average or above precipitation. Numbers in this period appear to have increased from those observed during the drought years of 2015, when no breeding blackbirds were located in the southern foothills. This 32% increase in breeding birds in the foothills over this period is generally consistent with the 23% increase in population recorded in the Statewide Surveys from the 2014 drought year to 2017 (Meese 2017).

The presence of breeding Tricolored Blackbirds in the southern foothills during the 2016 and 2017 years of average and above average precipitation suggests that breeding occurs regularly in this region during non-drought years.

Effects of High Rainfall on Breeding Population. The 2017 breeding survey provided a breeding population estimate in a very wet year, that adds to previous estimates for an average rainfall year (2016) and two drought years (2014 and 2015). Insect prey abundance is likely an important factor in nest success, but little information is available on how the amount and timing of annual rainfall affects prey populations or nesting success.

Notwithstanding some variation in survey effort, and despite the substantial variation in rainfall over the four-year period, breeding populations in the central foothills remained relatively constant (within 25%), at nearly 43,000 to 56,800 breeding birds. Breeding densities did not track with rainfall, with higher densities in the dry 2015 and very wet 2017 than in the average 2016 (Table 2). The differences in density, however, may simply reflect that the lower 2015 and 2017 survey efforts were sufficient in detecting all accessible colonies and the additional 2016 effort was superfluous.

Northern Foothills. The decline in colonies and nesting individuals in the northern foothills between 2016 and 2017 may be partly attributable to lack of surveys in Butte County. The decline in Yuba County where survey effort was similar did not appear to be associated with any substantial change in foraging or nesting habitat conditions. More likely, it reflects annual variation in numbers of breeders that is typical at the geographic scale of counties (Table 2).

Central Sierra Foothills. The increase in the 2017 central foothill breeding population from 2016 cannot be explained simply as a response to increased rainfall because numbers were also high in the 2015 drought year. Rather, high numbers in 2017 in the central foothills could reflect a variety of factors, including movements resulting from reduced availability of milk thistle nesting habitat in the southern foothills (see *Nesting Substrate*), or an overall increase in the species breeding population, as indicted by an increase in numbers recorded in the Statewide Tricolored Blackbird survey (Meese 2017). It is also possible that our recorded increase may have resulted from an increase in the proportion of birds in the population that attempted to breed.

The relatively high number and density of Tricolored Blackbirds in Sacramento County in 2017 warrants some historical comparison. As recently as 1994, the county supported over 100,000 breeding birds, but by 2002 numbers declined dramatically to 5,000 breeding birds due to removal of Himalayan blackberry nesting habitat and conversion of extensive areas of grassland foraging habitat to vineyards (Cook and Toft 2005). In that context, the 2017 population of 33,800 breeders, compared to a 2014-17 average of 20,300 breeders (Table 2) is encouraging but not necessarily reassuring, especially considering the continued threats to remaining habitat.

Southern Sierra Foothills. The 2015-2017 survey results in the southern foothills documented very few active colonies during the dry 2015 and the presence of a substantial breeding population in average and wet years (2016 and 2017). These results, along with historical records of nesting in this region, suggest that Tricolored Blackbirds may be regular breeders here in non-drought years.

That the southern foothills supported fewer breeders in the wetter 2017 than in 2016 may be due in part to the limited extent of milk thistle breeding habitat. The environmental factors in 2017 that led to fewer stands and slower growth of milk thistle during a wetter 2017 than in 2016 are unknown. Potential factors may include the amount and timing of rainfall, cooler spring temperatures, or perhaps the presence of thicker mulch that developed following two wet winters, as documented for other broadleaf species in southern foothill grasslands (Parsons and Stohlgren 1989).

A wetter 2017, however, appears to have enhanced growth of wetland vegetation, which was the sole substrate used for nesting at four of five colonies and by 86% of the nesting population in Madera and Merced counties. Apparent low nesting success due to drying of wetlands and resulting predation at the two major colonies in this region supports previous conclusions that this region supports a relatively unstable nesting population that could benefit from conservation efforts to provide more resilient wetland and blackberry nesting habitat.

Nesting Substrate

Predominant use of Himalayan blackberry in the northern and central foothills in 2017, as in 2014-16 (Airola et al. 2016) continues to demonstrate the importance of this nesting substrate in this region under all climatic conditions. Blackberry nesting sites demonstrate higher nesting success (Cook and Toft 2005, Holyoak et al. 2015) presumably due to better protection from predation. In contrast, our observations of higher incidence of predation and resulting nest failure in colonies within emergent wetlands are consistent with previous findings (Cook and Toft 2005, Holyoak et al. 2015).

Our observations do not support use of California wild rose (*Rosa californica*) as a native nesting substrate alternative for Himalayan blackberry. Wild rose and other native substrates are being tested experimentally in restoration on some state conservation lands where use of Himalayan blackberry and milk thistle is prohibited (Cook 2016). We have not observed Tricolored Blackbirds using wild rose in the foothills as a nesting substrate. Also, we have only observed use of the similar non-native sweetbriar rose only once (in 2017), over the four-year foothill study and only after adjacent Himalayan blackberry habitat appeared to be saturated. These observations suggest that the blackbirds may perceive it as inferior, possibly due to its more open, less robust, and less armored growth form.

The predominant use of emergent wetlands for nesting in the southern foothills in 2017, after predominant use of milk thistle in 2016 and apparent limited or lack of nesting in 2015 illustrates the dynamism in habitat availability and species uses of nesting habitat in the region. The 2017 shift in nesting substrates may be a result of substantially lower abundance of milk thistle, an increase in abundance of emergent wetland vegetation, or a combination of both. The variability in the availability of nesting substrate and observed predation within wetland colonies in 2017 supports our previous recommendations for the creation and enhancement of more protective and stable nesting habitat by establishing Himalayan blackberry nesting habitat and improving protection and management of milk thistle and emergent wetland habitats in this foothill subregion (Airola et al. 2016).

Nest Site Fidelity

Colony site use in 2017 was consistent with previous determinations that Tricolored Blackbirds in the foothill grasslands frequently shift nesting sites among years, presumably partly in response to changes in the distribution of concentrated insect prey (Airola et al. 2016). The 2017 results in the southern foothills from sites supporting milk thistle to emergent wetlands also reflects the different annual availability of various nesting substrates in this region. Frequent between-year movement of nest colony locations complicates efforts to enact conservation protections for the species (Airola et al. 2015b, 2016)

Habitat Losses during 2017

The continued development in Sacramento County, including the area immediately adjacent to the *Iron Point Road* colony, nesting site, and the Folsom Ranch development's elimination of grassland habitat where these birds regularly foraged (Figure 5), has reduced the quality of the colony site during and since its use in the 2017 breeding season. The future impact depends in part on the rate of development within the 30-year build-out of the project. Suitable nesting habitat at the nearby *White Rock Rd Inaccessible Pond* colony site south of White Rock Road, which was used in 2014, appears safe from imminent development. This site provides greater access to adjacent foraging habitat; the colony may relocate to this area or other nearby habitat.

The initiation of aggregate mining under the Aspen VIII-IX project, within the area that provided nesting habitat for the four 2017 colonies at the *Elder Creek* complex in Sacramento County, will alter lands that were extensively used by Tricolored Blackbird colonies during 2017 and over the four-year study period. The 13,500 breeding blackbirds that bred in this area during 2017 represents 8% of the estimated 2017 statewide population. Lands used for nesting and foraging at the Elder Creek complex will be taken out of irrigation as pasture, after which they will be mined and restored to annual grassland after completion of each mining phase (Sacramento County 2016).

Mitigation adopted for mining impacts to the Elder Creek colonies includes avoiding disturbance to active nesting birds, protecting the nesting habitat along Elder Creek with a conservation easement, planting California blackberry and California wildrose in protected areas onsite as nesting habitat, and preserving 371 acres of offsite foraging habitat (Teichert Aggregates 2014, Sacramento County 2016). One colony site (*Elder Creek #4*) within the protected Elder Creek corridor has been used successfully by 3,000 -5,000 birds in three of the last four years. Maintaining the Himalayan blackberry patches along the creek required establishment of irrigation to replace the runoff from the formerly irrigated pasture. Although not a requirement, fortunately the landowner voluntarily agreed to install irrigation at this site.

Tricolored Blackbirds regularly use other restored mining sites in the area surrounding the Elder Creek colonies, so use after reclamation is possible. Also, some blackberry patches that have been used successfully for nesting occur on adjacent parcels that won't be mined. Whether the local area will be able to maintain numbers of after mining and reclamation of current irrigated pasture to annual grassland remains to be seen. The response to these changes should be a priority for future monitoring.

Implications of Comparisons with the Statewide Survey

The triennial Tricolored Blackbird Survey was designed as a tool to apply a consistent methodology to estimate the statewide population and determine trends in species abundance. The April timing of the survey was purposefully selected to occur "when the maximum numbers of birds are breeding… and are thus more reliably found and easier to count" (Meese 2015). Selection of a survey date relatively early in the breeding season, however, disproportionately counts birds in southern portions of the breeding range (Meese 2017), and may not fully represent the breeding status of the species in more northern areas.

The inconsistency between numbers of Tricolored Blackbird observed on the Statewide Survey and the number of breeding birds recorded in the foothill breeding survey demonstrates that the Statewide Survey does not provide an accurate estimate of the breeding populations in the central foothill region. In early April in different years, the period of the Statewide survey, blackbirds in the foothills may be a combination of early breeders, migrants, or non-breeding birds.

The inconsistency in numbers between the two surveys likely reflects annual variability in the timing of movements to foothill areas to initiate breeding. These timing differences may result from annual weather differences in the foothills, and its effects on vegetation and insect prey (Airola et al. 2016, Meese 2017). The quality of habitat for breeding in the south also may delay or accelerate arrival at northern and higher elevation

foothill areas. Presumably, a similar situation could exist in other more northerly portions of the species' range.

The differences between the Statewide Survey and our colony surveys supports Meese's (2015) recommendation that additional regional, season-long assessments of breeding status, such as ours and that of Wilson et al. (2018) in central coastal California, are needed to more completely characterize the breeding status of the species in northern portion of the species range. Comprehensive studies of breeding populations, nesting success, and habitat use in northern regions would be important contributions to Tricolored Blackbird conservation. Alternatively, a second Statewide survey could be conducted during mid-May to acquire this information.

Conservation Implications

We have addressed conservation implications of our studies in past articles (Airola et al. 2015a, b, 2016). We report on additional implications based on the 2017 surveys.

Our estimate of the 2017 breeding population in the foothills as a whole further demonstrates the importance of this region to the species. The 72,800 breeding birds observed in the foothills, represents about 20% of the species entire annual breeding effort, assuming that the estimated statewide population 178,000 breeds twice per year (Beedy et al. 2017).

Surveys in the southern foothills in 2017 further clarify the breeding status of the Tricolored Blackbirds there, which was not well understood prior to our studies (Airola et al. 2016). Our studies suggest that breeding use of the southern foothills by Tricolored Blackbirds likely occurs during non-drought years, thereby increasing the conservation value of this region for the species.

Nesting substrate use in 2017 reinforces previous conclusions regarding the importance of Himalayan blackberry (Cook and Toft 2005, Meese and Beedy 2015, Airola et al. 2016). The changes in availability and the shift in use of different nesting habitats (milk thistle in 2016 and emergent wetland species in 2017) in the southern foothills demonstrates both the dynamism of this region and the species' ability to accept different substrates if in suitable condition for nesting. Observation of extensive predation of nests in emergent wetlands following declines in water levels over the nesting season supports previous conclusions that reproductive success is lower in this substrate than in Himalayan blackberry (Cook and Toft 2005, Holyoak et al. 2014). High predation rates and the variability in habitat availability and use in the southern foothills also indicates the benefits of developing more stable upland nesting habitat there (Airola and Young 2015, Airola et al. 2016).

Continued habitat losses in Sacramento County, which supports the highest breeding population of Tricolored Blackbirds in the foothills, should

prompt greater concern about the species' status there, and increased efforts to achieve meaningful, long-term conservation through maintenance of livestock grazing uses. The long-term fate of the Tricolored Blackbird requires resource agencies, conservation organizations, and private landowners to work together to protect nesting and foraging habitats, continue to improve population estimates, and encourage research that seeks answers to fundamental questions about regional populations sizes, breeding success, seasonal movements, and foraging ecology.

ACKNOWLEDGEMENTS

We thank the following organizations for contributions that supported field work and data analysis: Audubon California; Yosemite Area, Central Sierra, Stanislaus, and Fresno Audubon Societies; Northwest Hydraulic Consultants, Inc.; and Colibri Environmental Consulting. The following individuals, among many, assisted in supplying funding: Desiree Loggins, Samantha Arthur, Meghan Hertel, Willie Hall, Ed Pandolfino, Barry Bolton, Lowell Young, Joe Frank, and Jeff Davis.

We thank the many individuals who assisted with surveys or contributed information on colony locations, breeding status, and habitat conditions, including: Stacy Anderson, Samantha Arthur, Jennifer Brown, Kevin Cahill, Tara Collins, Chris Conard, Neil Clipperton, Jeff Davis, Kit DeGear, Rob Doster, David Dunham, Tim Fitzer, Greg Heming, Cheryl Johnson, Dan Kopp, Don Marsh, Bob Meese, Frances Oliver, Linda Pittman, Jeanne Ridgely, Aaron Rives, Evelyn Smith, Sam Sosa, Sabrina West, and Lowell Young. We especially thank landowners who provided access to examine colonies including Cheri Manica (Truck Parts for You), Rachel Hess and Tom Brandon (River Ranch), U. S. Bureau of Reclamation New Melones Reservoir, Ken McCoy and Jim Cochran (Madera Irrigation District), Merced Irrigation District, and Westervelt Ecological Services. Thanks to Barry Baba for discussion of mining at the Elder Creek colonies. Thanks also to Bob Meese for suggestions, organizing Statewide Survey surveyors, and maintenance of the Tricolored Blackbird Portal. Marcel Holyoak and an anonymous reviewer provided many useful comments on a previous draft. Thanks also to Ed Pandolfino for serving as guest editor for peer review of this paper.

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UPDATE:

Tricolored Blackbird Fully Listed as Threatened in California

At its April 19, 2018 meeting, the California Fish and Game Commission made a final determination to list the Tricolored Blackbird as Threatened under the California Endangered Species Act. The final listing replaces the temporary "Candidate" determination for the species. The decision to list was controversial, with some opposing groups arguing that the available information was inadequate to support the decision. The California Department of Fish and Wildlife, under the leadership of Neil Clipperton, did a highly credible job summarizing all available information on the biology and status of the species to inform the decision. Samantha Arthur and Mike Lynes of Audubon California also played a key role in informing the Commissioners and answering the opponents' arguments. Dr. Robert Meese also played a key role as the manager of the Tricolored Blackbird Statewide Surveys, which provided the data to support the determination of the species' declining status. Studies of the foothill population, conducted and supported by CVBC and many Audubon chapters, played a role in supporting the decision. Listing a species is not really a time for celebration, but it was the correct decision and will help keep protection programs in place and focus more conservation attention on the species.

Dan Airola
Editor