

TRICOLORED BLACKBIRDS' RELIANCE ON INSECTS FROM DAIRIES

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ABSTRACT: The Tricolored Blackbird has been in a severe population decline due to habitat loss and other factors. It is now heavily dependent on agricultural landscapes such as hay fields for foraging and grain fields for nesting. Dairies are known to provide a concentrated food source throughout the year in the form of grain gleaned from cattle feed. For nesting, however, Tricolored Blackbirds require large quantities of insects for their young. A colony of Tricolored Blackbirds in the San Jacinto Valley, Riverside County, in southern California, fed their young large numbers of house flies from nearby dairy-cattle yards, as well as drone fly larvae from dairy-effluent ponds. At this colony, 67% of the nestlings' food came from the dairy and another 13% from the adjacent hay fields. Most other insects came from irrigated weedy growth adjacent to wetlands. Such an intense reliance on dairies is risky for the blackbirds as urbanization is displacing the dairy industry in the San Jacinto Valley and many other areas of California. Another potential risk to the blackbirds is the use of pesticides at dairies for fly control. Further research is recommended to determine if this utilization of flies from dairies is widespread in California. Research is also needed to quantify the decrease of insects in drought-stricken landscapes and how this may affect the Tricolored Blackbird's reproductive success.

The Tricolored Blackbird (*Agelaius tricolor*) is a colonial songbird that has declined from an estimated 1.5 million nests representing 2–3 million birds in the 1930s (Neff 1937) down to a current estimated population of 218,000 birds (Meese 2022a). The species has a restricted range, with most of the population found in California's Central Valley and surrounding grasslands and smaller populations south to northern Baja California and north to Washington State (Unitt 2004, McCormick 2017, Beedy et al. 2018, Erickson et al. 2021). The species was listed as threatened under the California Endangered Species Act in 2018 (California Fish and Game Commission 2018). Loss of both of nesting sites and foraging habitat—grasslands and open shrublands—is the overarching cause for population declines (Hamilton 2004, Airola et al. 2015, 2023, Clipperton 2018). Prior to the widespread conversion of the Central Valley to agriculture, tricolors nested in vast marshes of cattails (*Typha* spp.) and bulrushes (*Schoenoplectus* spp.) (Neff 1937). They still nest in remaining wetlands, but nesting has shifted substantially to include tall weeds, blackberry thickets, nettles, and other dense and/or armored plants (Graves et al. 2013, Meese and Beedy 2015, Airola et al. 2016). Tricolors are now heavily dependent on agricultural landscapes. Many colonies nest in fields of triticale grown for silage for dairy cattle, where the birds are vulnerable to losses when the crop is harvested (Cook and Toft 2005, Meese 2006, Beedy et al. 2018, Castañeda et al. 2023). Hayfields, especially of alfalfa (*Medicago sativa*), pastures, and rangeland supply the large volume of insects the offspring require (Beedy et al. 2018, Airola et al. 2023). Foraging in the nonbreeding season is also in agricultural fields and grasslands and is often concentrated at dair-

ies and feedlots where virtually unlimited grain is available to be gleaned (Meese 2015).

Foraging for insects is opportunistic, with tricolors homing in on locally abundant large insects, often lepidopterous larvae or grasshoppers, though they consume a very wide variety of other taxa (Crane and DeHaven 1977, Meese 2013). When insect supplies are insufficient, nesting colonies can be entirely or partly abandoned and fewer young are produced. From 2006 to 2011 the reproductive output of many colonies statewide was low, with lower rates correlating with a reduced abundance of insect prey. Colonies near dairies suffered low reproductive output along with colonies distant from dairies (Meese 2013). Meese (*ibid.*) discussed the potential detriment to tricolors of feeding their young grain from dairies, since grains are difficult to digest and insufficient for growth of tricolors under nine days of age (Crane and DeHaven 1977, Skorupa et al. 1980). Thus low reproductive success near dairies could be attributed to feeding nestlings the food to which adults are accustomed, namely, grain.

In contrast, since 2018 the number of Tricolored Blackbirds nesting successfully in triticale in the San Joaquin Valley has increased thanks to coordinated protection of colonies (Castañeda et al. 2023). Even though the food sources for these colonies in triticale are not known, at least some tricolors nesting in agricultural settings are finding insects sufficient for successful nesting.

Tricolored Blackbirds have declined in southern California as well. In at least the past two decades, the northern San Jacinto Valley in Riverside County has supported the largest numbers of Tricolored Blackbirds in the region (Cook 2010). This agricultural valley is dominated by dryland grain farming and dairies that grow alfalfa, triticale, and other forage crops. Prominent in the valley is the 7700-hectare San Jacinto Wildlife Area (SJWA), where Tricolored Blackbirds have nested intermittently since at least 1988 (Beedy et al. 1991). The population in the northern San Jacinto Valley declined from a high of 35,000 birds in 1997, when the Western Riverside County Regional Conservation Authority initiated regular surveys (WRC-RCA 2011), to only 1600 birds in 2021 (Meese 2022b). Reasons for this decline are not fully understood, but one is loss of farmland, as housing and warehouses are fast encroaching on agricultural land in this region. An insufficient supply of insects at the SJWA was the suspected cause of nesting failures and/or low reproductive output in 2016 and 2017 (WRC-RCA 2016, 2017). For nesting in the San Jacinto Valley, the birds colonize marshes, flooded ditches, patches of dense weeds, flood-control channels and occasionally triticale fields. (Cook 2010, WRC-RCA 2011).

During the nonbreeding season in the San Jacinto Valley, Tricolored Blackbirds are most often seen congregating at dairies where they glean grain (A. Metcalf, compiler, San Jacinto Lake Christmas Bird Count, pers. obs.).

METHODS

In our study, Woodward was responsible for the field work, Diaz for the statistical analysis.

Study Site

In early May of 2022, Tricolored Blackbirds established a nesting colony on the SJWA, centered at 33.8623° N, 117.0726° W, next to Bridge Street Pond. The SJWA encompasses 237 hectares of restored wetlands, and it is contiguous with approximately 96 hectares of private hunt club wetlands. Both the private and public wetlands consist of shallow ponds maintained for waterfowl. These ponds are filled in September, drained in April and May, and disked during the summer on a rotating basis to reduce excessive cattail growth and to allow for cultivation of food plants favored by waterfowl. Interspersed with the wetlands are bands of riparian growth and upland habitats of alkali sage scrub, non-native grasslands, and weedy fields, in all of which Tricolored Blackbirds have foraged. The SJWA also manages spring/summer wetlands for the benefit of Tricolored Blackbirds. In 2022, all unirrigated habitat was exceptionally dry.

The colony was located in dense cattails with small patches of bulrushes in a marsh measuring approximately 75 × 130 m, bordered to the northwest by an extensive series of waterfowl ponds. To the northeast lies the bed of ephemeral Mystic Lake, dry in 2022, with a wide expanse of native forbs and introduced weeds, small and stunted due to the scant winter/spring rainfall. Fallow fields and a riparian channel were to the southeast, and a dairy to the southwest, with fields of alfalfa and perennial ryegrass (*Lolium perenne*) just across the road from the colony site. The closest dairy buildings are 1 km away. Tall weeds bordered the colony site, growing in a swath 5–10 m wide, sustained by seepage. These plants included introduced grasses, Prickly Sow-thistle (*Sonchus asper*), Cheeseweed (*Malva parviflora*), Horsetweed (*Conyza canadensis*), Tumbleweed (*Salsola tragus*), Curly Dock (*Rumex crispus*), Lamb's Quarters (*Chenopodium album*), and other species of the Chenopodiaceae. The dominant weed adjacent to the colony was the non-native Perennial Pepperweed (*Lepidium latifolium*). Once the birds settled into this site, the water depth was maintained at about 0.5 m until the birds were finished breeding at the end of June.

We visited the colony approximately twice weekly, starting on 5 May during the establishment period, and continuing until virtually all nesting was complete on 1 July. Each observation period lasted 2–4 hours, for a total of about 40 hours at and near the colony. Our dual purpose was to identify the habitats in which the birds foraged and to identify the insects brought back for the young. Observations were of three types: (1) timed tallies of birds returning to the colony to feed their young, (2) observations of adults gathering food for their young in surrounding habitats, and (3) opportunistic observations of feeding behavior around the nesting colony.

Observational Methods

For observations at the colony, we used 10 × 42 binoculars while standing next to a car on the levee surrounding the marsh, approximately 50 m from the birds' activity. At this distance, the birds did not exhibit any alarm. We took photos with a point-and-shoot camera with 83× zoom of returning birds as they briefly perched with their bills full of insects prior to flying in to their young.

For the tallies of birds bringing food to nestlings or fledglings, on each day we visited the colony we counted the birds returning during periods of 10 minutes, one period for each direction from which the birds were bringing food. On most days, birds were returning from only two different foraging locations/directions. In these cases, we sampled the second line of returning birds about 3 minutes after finishing with the first line of birds, after having moved to a new vantage point from where we could get the most accurate tally. We defined a feeding visit as a bird returning to the colony either singly or as part of a line of birds, then dropping into the cattails, presumably to feed its young. Initially, we tried to count only birds carrying visible insects in their bills, but because some may have had food concealed within their bills, we reverted to counting any bird that entered the cattails as part of a returning feeding flock. For example, if seven birds returned together to the colony, at least some of which had visible food, we counted this as seven feeding visits. To observe tricolors foraging, we visually followed the lines of birds out to the sources of their insect supplies, generally on foot, sometimes by car. For long-distance tracking of outgoing flocks, we used a 10–60× spotting scope. Most foraging took place within 1.2 km of the colony, and all within 2 km. The area where the birds were feeding could be located in all cases but one. For birds foraging at the dairy, we could not enter the premises but were given permission to observe the birds from the boundary road, which allowed observation at distances of about 20 to 100 m. We identified adult flies on the basis of Gerry (2015) and InfluentialPoints.com (2013) and the immature stages of drone flies from Essig (1926) and Pfister and Kaufman (2009). We took photos of birds with insect prey in their bills as they paused briefly at the edge of the dairy, prior to their flying toward the colony.

Data Preparation and Statistical Analysis

To standardize comparisons of the nesting colony's relative preference for different feeding habitats on different days, we transformed counts of individual feeding visits into proportions of the total counts from each habitat on a given observation day. To investigate the relationship between habitat and the likelihood of observing a feeding visit, we ran a regression analysis with habitat as a predictor variable and proportion of daily total counts as the response variable. Although this response variable takes a value from 0 to 1, its distribution is not continuous because the counts represent a binary outcome (feeding visit observed or not). Therefore, these data violate the assumptions for standard linear regression, which require a scalar response. Instead, we used logistic regression to model the proportion of daily total counts as a binary response variable. In this method, a generalized linear model (Nelder and Wedderburn 1972) with a binomial distribution and logit-link function represents the relationship between the predictor (habitat) and the logarithm of the odds of a feeding visit being observed.

The quality of the model's fit was estimated with McFadden's pseudo R^2 , a relative measure that quantifies the improvement in the model's fit by comparing the log-likelihood of the fitted logistic regression model to the log-likelihood of the null (intercept-only) model (McFadden 1974). McFadden's pseudo R^2 differs from the R^2 in linear regression, which is a measure of the proportion of the variance explained by the predictors in the model.

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Both of these values range from 0 to 1, with higher values indicating a better fit. However, values of McFadden's pseudo R^2 are generally low, with a value from 0.2 to 0.4 representing a model with "excellent fit" (McFadden 1977).

RESULTS

We estimated that 700–800 adult tricolors, plus a few Red-winged Blackbirds (*Agelaius phoeniceus*) and one pair of Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*), constituted the colony. Settling, nest-building, and egg-laying took place during the first two weeks of May. Foraging flocks during this period were concentrated at a dairy 1.2 km away, and we presumed that the birds were still gathering grain from the cattle feed as they had during the nonbreeding season at this and other local dairies. No foraging was observed in the alfalfa and perennial ryegrass fields located between the dairy buildings and the colony site during this phase. Incubation started around 18 May, as determined from bioacoustic data from a recorder next to the marsh (Schackwitz 2022). Once the eggs began hatching, the birds continued to concentrate their activity on the closest dairy. Figures 1 and 2 summarize the 5175 feeding visits tallied through 1 July, when all birds had fledged. During this interval, the birds foraged in three habitats/locations: the dairy cattle yards and effluent ponds, the hayfields adjacent to the colony, and weedy fields both adjacent to the colony and up to 1 km away on the dry bed of Mystic Lake. One small set of incoming birds on 12 June could not be tracked; these are listed as unknown.

Our observations of daily feeding visits are well represented by a logistic

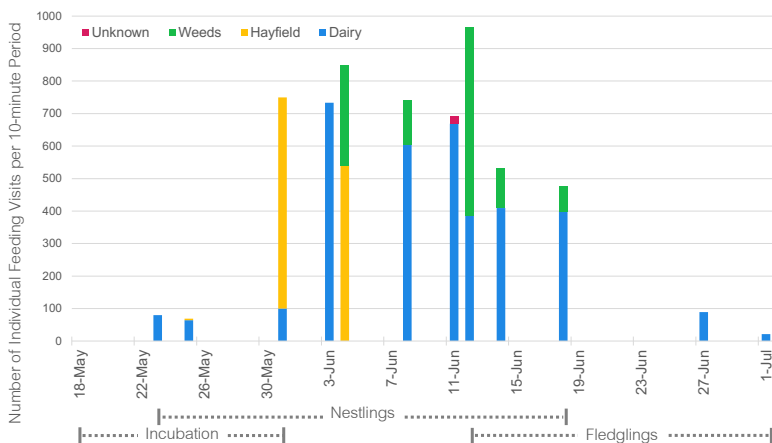


FIGURE 1. Number of feeding visits by date and habitat of Tricolored Blackbirds nesting at the San Jacinto Wildlife Area, 2022. A feeding visit is defined as an individual bird observed to be or presumed to be carrying food into the colony for its young during a 10-minute period (see Methods). Totals for 12 June likely include some return visits by the same individuals foraging in weeds very close to the colony.

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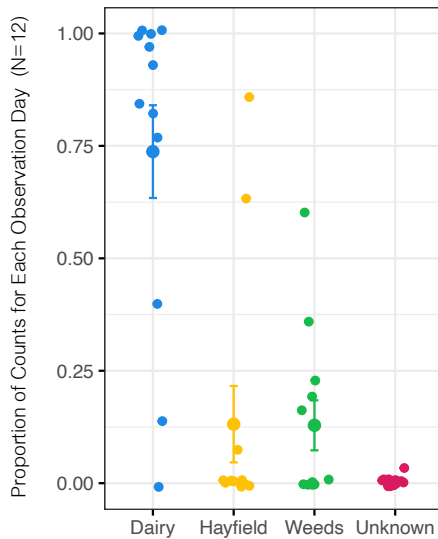


FIGURE 2. Mean proportions (with 95% confidence intervals) of total counts of Tricolored Blackbirds arriving at the colony at the San Jacinto Wildlife Area from each habitat (dairy, hayfield, weeds, and unknown) by observation day ($n = 12$).

model that takes habitat (dairy, hayfield, weeds, or unknown) as a predictor variable. The value of McFadden's pseudo R^2 is 0.41, indicating an excellent fit (Table 1). On the basis of our model, we are 95% confident that for a given 10-minute interval during the total observation period, the probability of observing a feeding visit from the dairy was between 0.64 and 0.81 (Figure 1). The odds of observing a feeding visit from either the hayfield or the weeds was 0.05 times the odds of observing a feeding visit from the dairy ($p < 0.001$). Feeding visits from unknown sites were highly unlikely, but the small number of observations did not permit further statistical interpretation ($p = 0.06$).

Overall, two-thirds of the feeding visits were from the dairy. During the nestling stage, tricolors coming from the dairy were mostly carrying clusters of small dark winged insects, generally too small or mangled to allow for accurate identification. On a 4 June visit to the dairy, we watched about

TABLE 1 Logistic Regression Model Relating the Proportion of Feeding Visits to the Tricolored Blackbird Colony at the San Jacinto Wildlife Area to Foraging Habitats^a

Variable	Estimated coefficient	Standard error	<i>t</i>	<i>p</i>
Dairy (intercept)	1.0319	0.4381	2.356	0.023
Hayfield	-2.9223	0.7197	-4.060	<0.001
Weeds	-2.9439	0.7234	-4.070	<0.001
Unknown	-6.9181	3.6943	-1.873	0.068

^aMcFadden's pseudo $R^2 = 0.414$.

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200 tricolors walking about in the cattle pens, snapping up insects from on or near the ground with short directed flights and lunges. They also flipped over flakes of manure, and although we did not see any insects taken in this manner, this maneuver appeared to be foraging behavior. Other groups of tricolors emerged from farther inside the dairy, flying low back toward the colony, sometimes landing briefly on low shrubs or fence lines with their bills packed with winged insects. Photographs showed these to be medium-sized muscoid flies (superfamily Muscoidea) (Figure 3). The vast majority of the flies alighting nearby were house flies (*Musca domestica*), and we concluded that this was the main prey item the birds were obtaining at the dairy.

In early June, we began seeing tricolors returning from the dairies with bills packed with larvae of the drone fly (*Eristalis tenax*) with their characteristic breathing siphons visible (Figures 4, 5). On 7 June, we watched from a distance of 100–140 m a flock of about 200 tricolors walking slowly around the partially filled dairy-effluent ponds, concentrated at the edge of open water, probing frequently into the muck with their bills inserted deeply into the substrate. This probing was notably different from the lunges and short flights observed at the cattle yards, and since this was the only wetland or muddy habitat in this foraging area, it clearly was the source of the drone fly larvae brought back to the nestlings. A few of the birds at the effluent ponds also hunted among the horseweed and on the dry mud at the pond edges. During mid-June, the birds coming from the dairy were spread out, and it was difficult to distinguish how many originated at the cattle yards and how



FIGURE 3. Female Tricolored Blackbird with flies from nearby dairy.

Photo by David M. Goodward



FIGURE 4. Female Tricolored Blackbird with drone fly larvae from nearby dairy.

Photo by David M. Goodward



FIGURE 5. Male Tricolored Blackbird with drone fly larvae from nearby dairy.

Photo by David M. Goodward

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many came from the effluent ponds. On 11 June, a 10-minute count from the edge of the dairy property yielded 329 returns from the effluent ponds and 340 from the cattle yards. This result suggested that, on at least some occasions, drone fly larvae provided a major source of food for the nestlings.

In mid-June, a few Tricolored Blackbirds brought orange-tinted, curved flakes back from the dairy for their nestlings (Figure 6). From photographs, the dairy owner identified these as almond hulls, a readily digestible, high-protein feed for cattle (Swanson et al. 2021). Almond hulls are the relatively soft layer around the hard shell of the almond. We did not quantify how many almond hulls were brought to the colony, but they were clearly outnumbered by insect prey.

In addition to the 67% of the feeding visits coming from the dairy, another 13% came from the hay fields between the colony and the dairy. The birds searched here during and immediately after the hay was cut (both alfalfa and ryegrass), and also when it was being irrigated by overhead sprinklers. We did not quantify the types of food brought in from these fields but did frequently note lepidopterous larvae.

The remaining 20% of feeding visits originated in rank weedy vegetation next to the colony and the waterfowl ponds as well as up to 1 km out on the bed of Mystic Lake. Nearby Perennial Pepperweed provided food for the tricolors in the form of swarms of small and medium-sized flies, including house flies, that were nectaring at the flowers. The tricolors picked flies off of the flowers and also foraged underneath their canopy for other unidentified insects.



FIGURE 6. Female Tricolored Blackbird with almond hulls from nearby dairy.

Photo by David M. Goodward

We observed foraging in semi-native upland habitat only on 9 June, when 115 tricolors in small flocks hunted in a dry weedy drainage channel and adjacent alkali scrub, capturing grasshoppers (*Trimerotropis* sp.) from among the scattered saltbushes (*Atriplex* spp.). Since these birds were seen at a foraging area rather than counted as they flew in to the colony site, they are not included in Figures 1 and 2.

Foraging within the marsh itself was restricted to tricolors hawking for insects above the cattails. These birds, mostly males, would fly slowly upward, stretch their heads up and snag a single insect, then drift back down to the cattails. They would often consume these captures themselves rather than take them to nestlings. In past years at the SJWA, we identified mayflies (Ephemeroptera) and a species of earwig (*Labidura riparia*) as slow-flying prey taken above the marsh, but other insects are likely taken this way as well.

After many of the young had fledged and were accompanying adults away from the colony (18 and 27 June and 1 July), small flocks of tricolors (and many Red-winged Blackbirds) frequented the drying waterfowl ponds, picking insects and/or seeds off of the surface of the mud and from the weedy berms. Red-winged Blackbirds fed on the seeds of Canary Grass (*Phalaris* sp.) but this grass was ignored by the tricolors, which did, however, feed on the unripe seeds of Japanese millet (*Echinochloa esculenta*) planted for wildlife by the SJWA's staff. Surveys were ended on 1 July. We did not quantify reproductive success but noted flocks of 20–80 immatures and adults in the fields and wetlands surrounding the colony and at the dairy pens and effluent ponds. We did not see large crèche concentrations of juveniles, suggesting overall reproductive success was fairly low.

DISCUSSION

Flies have previously been documented as one of many insect groups tricolors consume (e.g., Skorupa et al. 1980, Cook 2016). Our observations are notable in that immature and adult flies from a dairy constituted the main food source for the nestlings and fledglings at a Tricolored Blackbird colony.

The two most common nuisance flies at dairies in California and over much of the United States are house flies and stable flies (*Stomoxys calcitrans*) (Meyer and Peterson 1983, Meyer and Shultz 1990, Gerry 2008), and the local dairy owner corroborated my observation that the house fly is the most common species at his dairy. The larvae of drone flies are known as rat-tailed maggots, and they commonly occur in stagnant water and muck, often high in organic matter and low in oxygen (Pfiester and Kaufman 2009). They are commonly reported from cattle-effluent ponds (Day 2008, Wilson et al. 2009). Since both house flies and rat-tailed maggots occur regularly in high numbers at dairies, they may constitute a reliable food source for tricolors when other insect prey is not available.

The tricolor's use of almond hulls as food has not previously been documented. Even though the hulls do not look like grain, the tricolors have learned to recognize them as a potential food. We cannot estimate how many almond hulls were brought in, or say whether or not they contributed to successful fledging, but the consumption of almond hulls is something to be looked for in other colonies near dairies.

Our observations are another demonstration of the Tricolored Blackbird's ever-increasing dependence on agricultural landscapes. Adding in the 13% of the feeding visits originating in the dairy's hay fields raises the nestlings' and fledglings' dependence on dairies to 80%. Why did the tricolors largely ignore the thousands of acres of open grassland and wetlands at the SJWA and focus on the dairies? The simplest answer is that they were being opportunistic by using the most concentrated and reliable food source close to their colony.

We strongly suspect that in 2022 drought reduced the number of insects in unirrigated land, forcing the birds to forage for insects at the dairy. During the 2021–2022 rainy season (October–April), precipitation at Hemet, 6 km from the study site, was 151 mm, compared to the previous 30 years' average of 247 mm (National Weather Service 2023). T. Trakes of SJWA confirmed the area was notably dry, with little bloom of annual plants and sparse growth in unirrigated habitats. The failure of the tricolors' attempt to nest in April 2022 is further evidence that neither the wetlands themselves nor the surrounding upland fields had enough insects to support a robust colony in such a dry year. The birds at this early colony (3 km from the dairies) foraged mostly in the dry fields adjacent to the nesting marsh. Although multiple biologists observed feeding visits and fecal-pellet removal there (Nick Peterson, pers. comm.), the colony dwindled toward the end of April as the birds moved to Bridge Street Pond, which, significantly, is only about 1 km from the dairies.

There have been no long-term studies of insect abundance in southern California grasslands or scrublands, which could confirm the apparently obvious consequence of drought-induced desiccation of vegetation, that is, the subsequent loss of insect biomass. In Baja California, the southernmost population of the Tricolored Blackbird is on the verge of extirpation due to “chronic drought, rising temperatures, and habitat losses” (Erickson et al. 2021:207). Important rangeland populations of the tricolor in the southern Sierra Nevada foothills have been depressed by drought by reducing nesting substrates (Airola et al. 2016). In 2021, Castañeda et al. (2023) noted a drought-related population reduction in the Sierra foothills, though it was not clear whether it was due to a reduction in breeding substrate or in food availability. Given this context, we believe that the dairy was the dominant and perhaps only source of abundant insects available to the tricolors near SJWA in 2022, owing to a drought-induced dearth of insects elsewhere.

The Tricolored Blackbird's dependence on dairies raises concerns, including exposure of the birds to pesticides. Clipperton (2018) and others have warned that the species may be susceptible to reproductive losses from pesticides. Dairies are often subject to complaints over nuisance flies, especially in areas like the San Jacinto Valley that are undergoing conversion to suburbs, and dairy owners may resort to pesticides in response. Dairy operators are also concerned with stable flies because their painful bites distress the cattle and reduce milk production when the flies are abundant (Gerry et al. 2007). Pesticides are often used to control stable flies (ElAshmawy et al. 2021), and Tricolored Blackbirds might inadvertently be affected by this practice. It would be beneficial if the San Jacinto Valley tricolors could be “weaned” from dairy foraging, at least in the breeding season, by a reinstatement and expansion of irrigated foraging habitat at the SJWA, such as that reported by Cook (2016). In the short term, tricolors will likely continue to use the con-

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centrated food dairies provide, yet wildlife agencies need to plan for the time when those resources are no longer available. The dairies of the northern San Jacinto Valley are following the pattern widespread in southern California, in which the dairy owners are selling their properties to developers for urbanization (Hirsch 2006). The SJWA will remain, but the dairies likely will not.

We suggest that researchers monitoring Tricolored Blackbird nesting in silage crops in the San Joaquin Valley make efforts to evaluate the contributions of foraging at dairies for flies. This practice may actually be widespread, and it may contribute substantially to the blackbird's conservation statewide, especially in drought years. The tricolor's use of almond hulls at dairies also needs further investigation. The threats to the Tricolored Blackbird posed by the reduction in size of the dairy industry statewide may be unappreciated and warrant further study.

POSTSCRIPT

The 2022–2023 season saw exceptionally heavy rainfall in California, with 546 mm at Hemet (<https://www.weather.gov/wrh/climate?wfo=sgx>). The 2022 colony site was not occupied as of the time of publication, but elsewhere on the SJWA, 1 km from a different dairy, a colony of 1200 tricolors bred successfully in April and May 2023, feeding their young mostly on lepidopteran larvae from lush non-native grasslands. Only two tricolors were seen at the dairies in 11 hours of observation spread over eight days of the provisioning period. A small late nesting was initiated at the site the birds used in 2022, but it was abandoned prior to hatching for unknown reasons.

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LITERATURE CITED

- Airola, D. A., Meese, R. J., and Krolick, D. E. 2015. Tricolored Blackbird conservation status and opportunities in the Sierra Nevada foothills of California. *Central Valley Bird Club Bull.* 17:57–78.
- Airola, D. A., Ross, D., Swarth, C. W., Lasprugato, D., Meese, R. J., and Marshall, M. C. 2016. Breeding status of the Tricolored Blackbird in the grassland-dominated region of the Sierra Nevada, California, in 2016. *Central Valley Bird Club Bull.* 19:82–109.
- Airola, D. A., Collins, T. L., McColl, C. J., Lozano, M. R., Furnas, B. J., and Krolick, D. E. 2023. Foraging habitat and its effects on the Tricolored Blackbird's breeding distribution and abundance in the Sierra Nevada foothills, California. *W. Birds* 54:19–31; doi.org/10.21199/WB54.1.2.
- Beedy, E. C., Sanders, S. D., and Bloom, D. A. 1991. Breeding status, distribution, and habitat associations of the Tricolored Blackbird (*Agelaius tricolor*) 1850–1989. U.S. Fish and Wildlife Service, Sacramento, CA; <https://tricolor.ice.ucdavis>.

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- edu/sites/g/files/dgvnsk3096/files/inline-files/Beedy%2C%20Sanders%2C%20and%20Bloom%201991.pdf.
- Beedy, E. C., Hamilton, W. J. III., Meese, R. J., Airola, D. A., and Pyle, P. 2018. Tricolored Blackbird (*Agelaius tricolor*), version 1.0, in *Birds of the World* (P. G. Rodewald, ed.). Cornell Lab Ornithol., Ithaca, NY; doi.org/10.2173/bow.tribla.01.
- California Fish and Game Commission. 2018. Notice of findings, Tricolored Blackbird (*Agelaius tricolor*); <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=161202%20&inline>.
- Castañeda, X., Clipperton, N., Airola, D. A., Arthur, S., and Sousa, P. 2023. Effectiveness of public–private efforts to conserve Tricolored Blackbird colonies on agricultural lands in the San Joaquin Valley, California. *W. Birds* 54:2–18; doi.org/10.21199/WB54.1.1.
- Clipperton, N. 2018. February 2018. Report to the Fish and Game Commission: A status review of the Tricolored Blackbird (*Agelaius tricolor*) in California; <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=154287>.
- Cook, L. F., and Toft, C. A. 2005. Dynamics of extinction: Population decline in the colonially nesting Tricolored Blackbird (*Agelaius tricolor*). *Bird Cons. Int.* 15:73–88; doi.org/10.1017/S0959270905000067.
- Cook, R. 2010. Recent history and current status of the Tricolored Blackbird in southern California. A report of the Western Riverside County Multiple Species Habitat Conservation Plan. WRC-RCA Biological Monitoring Program, 4500 Glenwood Drive, Bldg. C, Riverside, CA 92501.
- Cook, R. 2016. Enhancement of Tricolored Blackbird breeding habitat at the San Jacinto Wildlife Area. California Department of Fish and Wildlife LAG# P1382102. WRC-RCA Biological Monitoring Program, 4500 Glenwood Drive, Bldg. C, Riverside, CA 92501.
- Crase, F. T., and DeHaven, R. W. 1977. Food of nestling Tricolored Blackbirds. *Condor* 79:265–269; doi.org/10.2307/1367173.
- Day, E. R. 2008. Livestock area fly control. Virginia Tech Extension (5 February 2009); https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/456/456-016/ENTO-522B.pdf.
- ElAshmawy, W. R., Abdelfattah, E. M., Williams, D. R., Gerry, A. C., Rossow, H. A., Lehenbauer, T. W., and Aly, S. S. 2021. Stable fly activity is associated with dairy management practices and seasonal weather conditions. *PLoS One* 16(7):e0253946; doi.org/10.1371/journal.pone.0253946.
- Erickson, R. A., de la Cueva, H., and Zamora-Hernández, E. D. 2021. Requiem for the Tricolored Blackbird in Mexico? *W. Birds* 52:207–221; doi.org/10.21199/WB52.3.2.
- Essig, E. O. 1926. *Insects of Western North America*. Macmillan, New York.
- Gerry, A. C. 2008. Management of nuisance flies: Dairy design and operational considerations. Dept. of Entomology-041, College of Agricultural and Natural Sciences, Univ. Calif., Riverside, CA 92521.
- Gerry, A. C. 2015. Pests of homes, structures, people, and pets. Flies. UC ANR Publ. 7457. Univ. Calif., Riverside; <https://ipm.ucanr.edu/PMG/PESTNOTES/pn7457.html>.
- Gerry, A. C., Peterson, N. G., and Mullens, B. A. 2007. Predicting and controlling stable flies on California dairies. Publ. 8258, Div. Agriculture and Natural Resources, Univ. Calif., Riverside; doi.org/10.3733/ucanr.8258.
- Graves, E. E., Holyoak, M., Kelsey, T. R., and Meese, R. J. 2013. Understanding the contribution of habitats and regional variation to long-term population trends in Tricolored Blackbirds. *Ecol. Evol.* 3:2845–2858; doi.org/10.1002/ece3.681.
- Hamilton, W. J. III. 2004. Tricolored Blackbird management recommendations and 2005 survey priorities. Report to California Resource Management Institute, 1121 L Street, Suite 809, Sacramento, CA 95814. 15 pp.

TRICOLORED BLACKBIRDS' RELIANCE ON INSECTS FROM DAIRIES

- Hirsch, J. 2006. Dairies moving out of Inland Empire. Los Angeles Times; <https://www.latimes.com/business/la-fi-dairy9jan09-story.html>.
- InfluentialPoints.com. 2013. Services for ecologists, medics and veterinarians. Stable flies, house flies and face flies; https://influentialpoints.com/Gallery/Stable_flies_and_Face_flies.htm.
- McCormick, A. J. 2022. The Tricolored Blackbird in Washington State: First assessment of status and distribution. *W. Birds* 53:186–198; doi.org/10.21199/WB53.3.1.
- McFadden, D. 1974. Conditional logit analysis of qualitative choice behavior, *in* *Frontiers in Econometrics* (P. Zarembka, ed.), pp. 105–142. Academic Press, New York; <https://eml.berkeley.edu/reprints/mcfadden/zarembka.pdf>.
- McFadden, D. 1977. Quantitative methods for analyzing travel behaviour of individuals: Some recent developments. *Cowles Foundation Discussion Papers* 707, Yale Univ., New Haven, CT; <https://elischolar.library.yale.edu/cowles-discussion-paper-series/707>.
- Meese, R. J. 2006. Settlement and breeding colony characteristics of Tricolored Blackbirds in 2006 in the Central Valley of California. Report to the U.S. Fish & Wildlife Service, Sacramento, and Audubon California, Emeryville, CA; <http://tricolor.ice.ucdavis.edu/about-tricolored-blackbirds>.
- Meese, R. J. 2013. Chronic low reproductive success of the colonial Tricolored Blackbird 2006–2011. *W. Birds* 44:98–113.
- Meese, R. J. 2015. Recovering the Tricolored Blackbird in California. *Central Valley Bird Club Bull.* 17(2–4):97–109.
- Meese, R. J. 2022a. Results of the 2022 statewide survey. Dept. Env. Sci. and Policy, Univ. Calif., Davis; <https://tricolor.ice.ucdavis.edu/news/results-2022-statewide-survey>.
- Meese, R. J. 2022b. Results of 2021 southern California survey. Dept. Env. Sci. and Policy, Univ. Calif., Davis; <https://tricolor.ice.ucdavis.edu/news/results-2021-southern-california-survey>.
- Meese, R. J., and Beedy, E. C. 2015. Managing nesting and foraging habitats to benefit breeding Tricolored Blackbirds. *Central Valley Bird Club Bull.* 17:79–96.
- Meyer, J. A., and Peterson, J. J. 1983. Characterization and seasonal distribution of breeding sites of stable flies and house flies (Diptera: Muscidae) on eastern Nebraska feedlots and dairies. *J. Econ. Entomol.* 76:103–108; doi.org/10.1093/jee/76.1.103.
- Meyer, J. A., and Shultz, T. 1990. Stable fly and house fly breeding sites on dairies. *Calif. Agric.* 44(1):28–29; doi.org/10.3733/ca.v044n01p28.
- Neff, J. A. 1937. Nesting distribution of the Tricolored Red-wing. *Condor* 39:61–81; doi.org/10.2307/1363776.
- Nelder, J. A., and Wedderburn, R. W. M. 1972. Generalized linear models. *J. Royal Stat. Soc., Ser. A* 135:370–384; doi.org/10.2307/2344614.
- Pfiester, M., and Kaufman, P. E. 2009. Featured creatures: Drone fly, rat-tailed maggot. *Publ. EENY-445*, Univ. Fla.; doi.org/10.32473/edis-in809-2009.
- Schackwitz, W. 2022. Bioacoustics monitoring of San Jacinto Wildlife Area Tricolored Blackbirds. 2022 Final Report. Point Blue Cons. Sci., Petaluma, CA.
- Skorupa, J. P., Hothem, R. L., and DeHaven, R. W. 1980. Foods of breeding Tricolored Blackbirds in agricultural areas of Merced County, California. *Condor* 82:465–467; doi.org/10.2307/1367578.
- Swanson, K. L., Bill, H. M., Asmus, J., Heguy, J. M., and DePeters, E. J. 2021. Feeding high amounts of almond hulls to lactating cows. *J. Dairy Sci.* 104(8):8846–8856; doi.org/10.3168/jds.2020-19109.
- Unitt, P. 2004. San Diego County bird atlas. *Proc. San Diego Soc. Nat. Hist.* 39.
- WRC-RCA. 2011. Western Riverside County Multiple Species Habitat Conservation Plan Biological Monitoring Program. 2010 Tricolored Blackbird (*Agelaius*

TRICOLORED BLACKBIRDS' RELIANCE ON INSECTS FROM DAIRIES

- tricolor*) survey report with overview of recent history and current status in southern California. WRC-RCA Biological Monitoring Program, Riverside, CA; <https://www.wrc-rca.org/species-surveys/>.
- WRC-RCA. 2016. Western Riverside County Multiple Species Habitat Conservation Plan Biological Monitoring Program. 2016 Tricolored Blackbird (*Agelaius tricolor*) survey report. WRC-RCA Biological Monitoring Program, Riverside, CA; <https://www.wrc-rca.org/species-surveys/>.
- WRC-RCA. 2017. Western Riverside County Multiple Species Habitat Conservation Plan Biological Monitoring Program. 2017 Tricolored Blackbird (*Agelaius tricolor*) survey report. WRC-RCA Biological Monitoring Program, Riverside 92501, CA; <https://www.wrc-rca.org/species-surveys/>.
- Wilson, D. J., Gerard, P. J., and de Villiers, J. E. 2009. Preventing rat-tailed maggot incursion into dairy sheds. *New Zealand Plant Protection* 62:99–102; doi.org/10.30843/nzpp.2009.62.4792.

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