Detection, Monitoring, and Fates of Tricolored Blackbird Colonies in 2010 in the Central Valley of California

Final Report

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Introduction

The tricolored blackbird (*Agelaius tricolor*; hereafter tricolor) is a near-endemic California passerine and the most colonial songbird in North America (Beedy and Hamilton 1999). Due to a variety of factors including habitat loss through conversion to agriculture and urbanization, market hunting, poisoning, and shooting as an agricultural pest, the number of tricolors plummeted during the 20th Century (Neff 1937, Beedy and Hamilton 1999), leading to a petition by the Center for Biological Diversity to list the tricolor under the protections afforded by the State of California and Federal Endangered Species Acts (CBD 2004). Although these petitions were denied, the tricolor remains a species of conservation concern (USFWS 2002) and a California Bird Species of Special Concern (Shuford and Gardali 2008).

This report describes field work conducted between May 7 and August 3, 2010 to detect, monitor, and estimate the productivities of the largest tricolored blackbird breeding colonies in California's Central Valley and provides recommendations for conservation. This is the sixth year that I have conducted field work with tricolors and the fourth year that I have banded tricolors. The results of this year's banding efforts are described in a separate report (Meese 2010).

The field work described here and in previous reports (Hamilton and Meese 2006, Meese 2006, 2007, 2008, 2009) emphasizes the Central Valley, although the tricolor has two distinct population segments: the Central Valley population and the southern California population (DeHaven and Neff 1973, Beedy and Hamilton 1999), and historically has nested in large numbers in coastal marshes in southern California (Baird 1870, Neff 1937, Unitt 2004). Workers in southern California have documented severe population declines in the southern California population segment (Neff 1937, Beedy and Hamilton 1997, Unitt 2004, Kelsey 2008) and dedicated, intensive surveys in spring 2008, 2009, and 2010 document a continuing decline in abundance of tricolors in the six-county southern California region (Kelsey 2008, Feenstra 2009, Feenstra 2010). Small numbers of tricolors are also found in northern Baja California, western Nevada, southern Oregon, and, since 1998, southern Washington (Beedy and Hamilton 1999, Seattle Audubon Society Birdweb website, accessed August 2010), and as is the case in southern California, the Baja California population is in serious jeopardy (Erickson et al. 2007, Erickson and de la Cueva 2008).

Factors that currently limit tricolor productivity in the Central Valley include:

1) the relative lack of insects within the foraging radius of breeding birds
2) on-going conversions of potentially productive agricultural lands, primarily those planted in alfalfa, to perennial crops avoided by tricolors, primarily orchards (almonds and pistachios) and vineyards, which reduces the foraging habitat around colonies
3) the shooting of adult tricolors in the Sacramento Valley during and after the breeding season, and
4) predation by cattle egrets (*Bubulcus ibis*).

Habitat losses have accumulated for decades and are thought to be primarily responsible for the tricolor's severe population decline during the 20th Century (Beedy and Hamilton 1999). Losses to agriculture and urbanization have affected both nesting and foraging habitats by reducing both the amount of high quality nesting substrates (e.g., wetlands) as well as the amount of nearby foraging substrates that provide the insects required for breeding. Habitat losses continue and are primarily of two types: 1) reductions in the area of agricultural crops utilized by foraging tricolors via conversion to perennial crops shunned by foraging tricolors, and 2) conversions of formerly natural or semi-natural habitats (grasslands, shrublands) to perennial crops.

Losses of foraging habitats may reduce the ability of an area with suitable nesting habitat to support breeding by tricolors by reducing the abundance insects required for breeding (Ramsay and Houston 1998, Skorupa et al. 1980, DeHaven 2000). Such foraging habitat losses may result in declines in reproductive output (productivity) that occur over a period of years and are difficult to detect, but that may ultimately lead to situations where, despite the presence of suitable nesting substrate, tricolors abandon or decline to extinction in an area where they formerly were abundant. This mechanism is believed responsible for the near-extirpation of the species from southern California (Unitt 2004, Feenstra 2010) and Baja California (Erickson et al. 2007, Erickson and de la Cueva 2008).

In addition, most agricultural crops are routinely sprayed with insecticides, with the result that insect populations even on otherwise high-value tricolor foraging substrates (e.g., alfalfa, sunflowers) and in some lower-quality substrates (e.g., rice paddies) are kept artificially low. These efforts to reduce insect abundance in agricultural areas may reduce the output of nearby tricolor colonies as tricolor nestlings are obligate carnivores and dependent upon insects for the first 9 days of life (Crase and DeHaven 1977; pers. obs.).

The shooting of tricolors in the Sacramento Valley was again confirmed in 2010 by two Sacramento National Wildlife Refuge law enforcement officers who reported that they had observed the shooting of flocks of tricolors foraging in rice paddies adjacent to Delevan National Wildlife Refuge. The officers reported that they had contacted the individuals after observing them shooting foraging tricolors and had recovered five tricolored blackbird carcasses.

Predation by cattle egrets on the eggs and nestlings of tricolors was unknown prior to 2006, when it apparently arose spontaneously on a single colony in Tulare County (Meese 2006). In the 4 years since, it has become the most important biotic factor in reducing the productivity of tricolor colonies statewide. In 2009 and again this year severe predation by cattle egrets reduced to near-zero the reproductive output of large (several tens of thousands of breeding birds) colonies in Tulare County (Meese 2009, Frazer pers. comm.).

In addition to these impacts, the tricolor is also prone to reproductive failures due to stochastic events that may play important roles in tricolor population regulation and, hence, our efforts to conserve the species. From 2007 through 2009, severe drought conditions reduced insect abundance throughout California and led to widespread nesting failures (Meese 2007, 2008, 2009). The drought ended in 2010 but a series of late spring storms in April and May, 2010 brought winds that are believed to be responsible for extensive nest destruction in several large Merced County colonies.

This report summarizes efforts to monitor the Central Valley tricolor population during the 2010 breeding season, with a focus on detecting and determining the fates of the largest colonies, and provides suggestions for conservation actions that may benefit the species. Intensive annual monitoring is essential to provide information on the current status of the species, and whereas the triennial statewide survey provides an extensive snapshot across the entire state and can be used to document statewide population trends (Kelsey 2008), intensive annual monitoring is required to identify the specific factors that cause reproductive successes or failures. Knowledge of these factors and the discrimination between those factors that we may influence (e.g., shooting, possibly cattle egret predation) from those that we cannot (e.g., drought, storms, insect abundance) may help to guide efforts to conserve the species. Understanding the reasons for colony successes and failures will help land managers, especially agency personnel, better target their investments and may result in better outcomes for their efforts to conserve the species. The annual search for, monitoring, and documentation of the fates of the largest breeding colonies is an integral component of efforts to stem the population decline and to increase the numbers of tricolors in California.

Materials and Methods

Colony Detection. The start to the 2010 field season was delayed due to contracting issues. Field work began on May 7, 2010 with surveys of the San Joaquin Valley to detect and monitor colonies following the methods developed in 2006 (Meese 2006, 2007) and refined in 2008 (Meese 2008). Fundamentally, the colony detection efforts in the San Joaquin Valley consist of targeted searches of previously-documented colony locations supplemented by careful searches of silage fields adjacent to dairies. The locations of San Joaquin Valley dairies have previously been determined and plotted on maps which are taken into the field and used to guide search efforts.

Subsequent colony detection efforts in the Sacramento Valley consist of targeted searches of previously-documented colony locations supplemented by searches of sites that have been reported by numerous collaborators (state and federal agency personnel, readers of the Central Valley Birds Yahoo Group, birders) or entered into the Tricolored Blackbird Portal (http://tricolor.ice.ucdavis.edu).

Many colonies in the San Joaquin Valley were well established by the time that field work began and in several cases only visual estimates of productivity and reproductive success could be made because young had already begun to fledge. Reproductive success (RS) estimates derived from sampled colonies depend upon relatively synchronous colony chronology and young between 7 to 9 days of age (Hamilton and Meese 2006, see below).

Monitoring. I monitored all accessible sites until a colony failed or fledged its young. In most cases, colonies were monitored (i.e. observed from the closest public road if located on private property where permission to access had not been obtained, or by immediately adjacent roads if located on public property or on private property where permission to access had been obtained) approximately twice-weekly to assess current conditions as well as to best assess colony chronology to estimate optimal times for conducting reproductive success and breeding population size estimates.

Estimating Area Occupied. The dimensions of all colonies were visually estimated or directly measured via GPS. Dimensions of colonies are reliably estimated by careful observation of birds made from outside the colony as occupied vs. unoccupied portions of nesting substrate can easily be distinguished (assuming adequate visibility) based upon the birds' behavior. In nearly all cases, delimiting the dimensions of a colony consists of quietly observing a colony through binoculars, either from a vehicle parked or slowly driven around the perimeter of the substrate used by the breeding birds, or, where possible, by slowly walking around the perimeter of the nesting substrate. Birds will leave and then return to nests at intervals defined by the stage of the breeding cycle, with longest intervals when females are incubating eggs and shortest intervals when females are building nests and when both adults are feeding young. The perimeter initially determined by the birds' behavior is confirmed through subsequent monitoring activities, including on-site estimates of reproductive success (RS; see below) and colony population size (see below). Both visual estimates and coordinates directly measured by GPS were placed into Google Earth to measure the dimensions of the occupied area. In addition, in wetland colonies, areas believed to be unoccupied were searched after birds had finished breeding to confirm the absence of nests.

Estimating the Number of Breeding Birds. The number of breeding birds in a colony was estimated in either or both of 2 ways: 1) visually and/or 2) by nest sampling following the breeding season.

Visual estimates of the number of breeding birds were derived each time a colony was monitored by carefully observing a colony for from 5-30 minutes per visit. When possible, colonies were observed from multiple vantage points to most precisely estimate the number of birds present.

For colonies where permission to access had been obtained, I re-entered colonies after the young had fledged and both young and adults had left the area and estimated nest densities according to one of two methods. In milk thistle (*Silybum marianum*) nest substrates, I counted nests within a randomly-placed 3x6' sampling frame of ¾" PVC pipe. In cattail nest substrates, I counted nests within 6' wide line transects of lengths that varied from 50 to 300 feet. I documented start and end points of transects by GPS and computed the transect lengths by GPS or by the length measurement tool in Google Earth.

I used the number of nests in the sampled areas to derive estimates of the number of nests per acre and computed the number of nests constructed at a colony by multiplying the number of nests per acre by the number of acres occupied by breeding birds. I assumed that each male breeds, on average, with two females (Beedy and Hamilton 1999), and multiplied the number of nests by 1.5 to estimate of the number of breeding birds at a colony. This quantity then provides an independent estimate of the number of breeding birds, as the number of breeding birds is also visually estimated during monitoring activities.

Estimating Reproductive Success. I estimate reproductive success (RS), defined as the average number of young produced per nest, in two ways: by visual estimates or by sampling.

Visual estimates of RS are derived from visual estimates of the number of breeding birds and the number of fledglings. As one male breeds, on average, with two females (Beedy and Hamilton 1999), each two nests have three birds associated with them, so the product of the number of breeding birds multiplied by 2/3 (0.67) provides an estimate of the number of nests constructed. The visual estimate of the number of young fledged divided by the estimate of the number of nests constructed yields an estimate of the number of young fledged per nest (RS).

For colonies where permission to access had been obtained, I derived an estimate of RS by counting the contents of a random sample of nests when the average age of nestlings was believed to be 7-9 days old. Nestling age is determined by carefully observing the behavior of the adult birds, which changes from relatively inconspicuous and sedentary, indicating that females are incubating eggs and males are remaining out of sight on their territories, to conspicuous and highly mobile, with frequent, directional flights out from and back to the colony, indicating that both adults are feeding young. I counted the contents of a sample of 30 to over 100 nests per colony and divided the number of nestlings by the number of nests to derive an estimate of the average number of young produced per nest (= reproductive success, RS).

Estimating the Number of Young Produced. I estimated the number of young produced at colonies by either or both of two methods: 1) by repeated observations of young in groups (“crèches”) following fledging, and/or 2) by calculating the product of the number nests constructed by reproductive success (see above).

For most colonies, the number of fledged birds may often be carefully counted, especially for colonies where access has been granted, as young tricolors spend a minimum of several days in groups perched and calling (“food begging”) conspicuously from the tops of vegetation at the margins of colonies (Beedy and Hamilton 1999, pers. obs.). Typically, groups of fledglings will begin to leave the nesting substrate and fly up to perch high in nearby shrubs or trees approximately 4 days after fledging. However, crèches remain within the colony boundaries for up to two weeks or more if there are no nearby taller shrubs or trees, as is often the case in the “silage belt” of the southern San Joaquin Valley.

In cases where I estimated RS and the number of nests built by sampling, I estimated the number of young produced by multiplying the estimate of the number of nests by the average number of young produced per nest (RS). This estimate of the number of young produced serves as an independent check on the visual estimate of the number of young produced (= number of fledglings observed).

After the young had fledged from colonies in the San Joaquin Valley, I repeated these activities, and responded to reports of aggregations of tricolors in the Sacramento Valley (Yolo, Sacramento, Yuba, Colusa, Glenn, and Butte counties), where tricolors typically (Hamilton 1998), but not always (e.g., Meese 2006), move to breed again. I began to survey for settlements and colonies in the Sacramento Valley in late May and monitored colonies until they failed or until the young had fledged. The last young were observed to fledge at the Yolo Bypass Wildlife Area colony in Yolo County in early August.

I trapped and banded birds during the interval from mid-May to late July; the results of my banding activities are presented in a separate report (Meese 2010).

Results

Colonies Detected. Field work started on May 7 and ended on August 3, 2010. During this time I detected, or received reports of, a total of 24 occupied sites (Appendix I). Of these 24 sites, I confirmed occupancy by breeding tricolors in all but the two Los Angeles County sites, the Cuyama River site in San Luis Obispo County, and the John Smith Road site in San Benito County. These colonies were reported to me via email.

Colonies Monitored. I monitored 16 colonies in 2010 (Table 1). I surveyed for colonies throughout the San Joaquin Valley, but the late start date may have contributed to the lack of detection of any settlements or colonies in Kings, Fresno, and Madera counties, as grain fields where colonies had formed in recent years had already been harvested by my first day in the field. In addition, Scott Frazer, Kern National Wildlife Refuge, reported to me that three sites in Tulare County had been lost to cattle egret predation and another had already fledged its young prior to my first day in the field.

San Joaquin vs. Sacramento Valley. The number of breeding birds observed in the San Joaquin Valley was estimated to be about 236,800, while that in the Sacramento Valley was estimated to be about 84,945. Although not strictly independent, as recaptures of banded birds have shown some post-breeding movements from the southern San Joaquin to the northern San Joaquin Valley for presumed second breeding attempts, and lacking estimates for colonies that formed and were destroyed by cattle egret predation prior to the start of field work, these numbers may be useful for comparative purposes to gauge changes in numbers of breeding birds in the two regions through time.

Productivity. Overall, 2010 was the fourth straight year of limited productivity, but not as poor as the drought-induced statewide reproductive failure of 2007 (Table 1; Meese 2007). Approximately 2/3 of all fledglings produced by monitored colonies were produced by the new Bear Creek colony in Merced County. I was informed by Scott Frazer of Kern National Wildlife Refuge that three colonies in Tulare County had no known young fledged as a result of intense cattle egret (*Bubulcus ibis*) predation prior to the start of my field work (pers. comm.). This marks the fifth straight year that cattle egrets have preyed upon eggs and nestlings of breeding tricolored blackbirds in Tulare County but the first year when three colonies were known to suffer complete reproductive failure due to cattle egret predation in the same year.

Table 1. Fates of Tricolor Colonies Monitored.

Colony Name	County	Substrate	Number of Breeding Birds	Fate
Costa's	Kern	triticale	66,000	modestly productive, visually estimated 3-10,000 young produced
Kern NWR	Kern	cattails, bulrush	20,000	multiple settlements; modestly productive, visually estimated 1,200 young produced
ECLA Ponds	Kern	cattails, bulrush	15,000?	multiple settlements; modestly productive, visually estimated 1,000 young produced
Bear Creek	Merced	milk thistle	83,000	79,834 young produced due to extraordinarily high grasshopper abundance
Hulen Levee	Merced	Himalayan blackberry	25,000	visually estimated 7,000 young produced
Merced NWR	Merced	mustard and milk	10,000	multiple settlements; second colony essentially

Duck Slough		thistle		destroyed by storm; visually estimated 500 young produced
Frog Pond	Merced	cattails, bulrush	10,000	visually estimated 3,000 young produced
Main Canal	Merced	bulrush, cattails	800	visually estimated 200 young produced
Owens Creek	Merced	milk thistle, mustard	15,000	colony nearly destroyed by grazing sheep; visually estimated 1,500 young produced
Crane Ranch	Merced	Himalayan blackberry	2,000	much nest predation, likely by rats; visually estimated 300 young produced
San Felipe Ranch	Merced	milk thistle	2,000	colony largely destroyed during storm, hundreds of dead nestlings found on ground beneath nests; visually estimated 200 young produced
Conaway Ranch	Yolo	cattails, bulrush	18,900	5,292 fledglings produced, calculated via RS estimate
Yolo Bypass W.A.	Yolo	cattails, bulrush	2,500	visually estimated 750 fledglings produced
Delevan NWR T43	Yolo	cattails, bulrush	49,545	8,257 young fledged
Plumas Arboga	Yuba	cattails, bulrush	7,000	no young produced, colony likely disturbed
Openshaw Road	Butte	Himalayan blackberry	7,000	visually estimated 4,000 young produced; high grasshopper abundance

Reproductive Success. Reproductive success (RS) was estimated by sampling at Bear Creek in Merced County, Delevan T43 in Colusa County, and the Conaway Ranch in Yolo County (Table 2). The Bear Creek colony, located on a private cattle ranch and surrounded by open pasture, stands out as its reproductive success was almost six times that of Delevan T43 and more than three times that of Conaway Ranch. A grasshopper outbreak in the Sierra Foothills (Reiter 2010) was readily apparent around the Bear Creek colony and appeared to have supported the relatively high reproductive success at this location. Overall, the estimated reproductive success for all colonies monitored in 2010 was 119542 birds fledged from 217956 nests, or an RS of 0.55.

Reproductive success could not be estimated by conducting nest inspections and sampling colonies after young had fledged at several colonies due to the late start of my field work and difficulty in interpreting RS estimates when multiple settlements occur at a single site (Hamilton and Meese 2006). A reliable measurement of RS depends upon a large percentage of the nests containing young between seven and nine days old. To reliably determine RS, a colony must be synchronous, with the contents of most nests developing at about the same time (Hamilton and Meese 2006). Asynchronous colonies contain nests with contents developing at different times, and at any one time, nests containing eggs and nestlings of a wide range of ages may be present, thus making the fate of the nest attempt difficult to determine.

Table 2: 2010 Tricolor Reproductive Success Measurements Derived from Sampling.

Colony	Number of nests	Number of adults	Number of young/nest (RS)	Number of young produced
Bear Creek	55,440	83,000	1.44	79,834
Delevan T43	33,030	49,545	0.25	8,258
Conaway Ranch	12,600	18,900	0.42	5,292

Colony Abandonment. Two colonies in their early stages, where females had been seen carrying in nest materials, were confirmed to have been abandoned: a late colony on the south end of Unit 1 at Kern National Wildlife Refuge and South Cackler on the Merced National Wildlife Refuge. The reasons why these sites were abandoned are unknown, but the most likely causes were the late start dates (on or about June 1 for Kern and June 15 for South Cackler) and consequent lack of insects required for breeding (Ramsay and Houston 1998, Skorupa et al. 1980).

Storm Damage. Spring storms, and especially the winds associated with storms, played a major role in limiting the productivity of several colonies in 2010, especially those established in milk thistle in Merced County. The second settlement at Merced National Wildlife Refuge Duck Slough appeared to be nearly wiped out due to a storm with high winds on May 20, affecting a colony visually estimated to consist of 15,000 breeding birds. The nearby San Felipe Ranch colony was affected by the same storm, and when surveyed on May 27 was visually estimated to have suffered a greater than 50% mortality of nestlings, as hundreds of dead nestlings were observed on the ground beneath the milk thistle nesting substrate. The Bear Creek colony, also established in milk thistle, was not as severely impacted but hundreds of nests were observed to have been affected, most apparently shaken sideways during strong winds. The eggs in these nests were likely spilled out on to the ground while the nestlings were either ejected or forced to cling precariously to horizontal nest cups (Figure 1).

Figure 1. Tricolored blackbird nestlings in horizontal nest. Two of three nestlings are visible in this photo.

Condition of Nests. Since the discovery in 2007 that female tricolors may build nests but subsequently fail to lay eggs and abandon a nesting attempt (Meese 2007), I have attempted to discriminate between nests that appeared to be immaculate (never used) from those that did not (contained egg shell fragments, fecal sacs, droppings, feathers, etc.) while conducting nest inspections to calculate reproductive success. Table 3 contains a summary of the results of these efforts and shows that the proportion of immaculate nests varies substantially from colony to colony.

Table 3. Condition of Empty Tricolor Nests.

Site	Number of Nests Inspected	Number of Empty Nests	Immaculate (%)	Lived-in (%)	Pulled Down (%)
Bear Creek	59	19 (32%)	3 (16%)	16 (84%)	0
Delevan T43	459	324 (71%)	278 (86%)	28 (9%)	18 (5%)
Conaway Ranch	33	18 (55%)	6 (33%)	12 (67%)	0

Starvation. I documented apparent starvation at Delevan T43 while conducting nest inspections to estimate reproductive success (RS). I inspected 459 nests at Delevan, and of these, 10 contained one or more dead chicks that appeared emaciated and apparently died of starvation. Eight of the 10 observed emaciated nestlings were observed in a sample of 114 nests in a portion of the colony that was last to settle, suggesting that the rate of starvation of nestlings increased through time.

New Colonies. As in my previous five years of field work with tricolors, colonies in new locations were detected this year. In 2010, 14 colonies were detected by or reported to me in previously unknown locations:

1. Cuyama River, San Luis Obispo County
2. John Smith Road, San Benito County
3. Boschma West, Kern County
4. Frog Pond, Merced County
5. Main Canal, Merced County
6. Bear Creek, Merced County
7. China Island South, Merced County
8. San Felipe Ranch, Merced County
9. I-5 Right of Way, Merced County
10. South Cackler, Merced County
11. Conaway Ranch Berries, Yolo County
12. CR 102 and Kentucky Ave., Yolo County
13. Hwy. 20 and Woodruff Lane, Yuba County
14. Openshaw Road, Butte County

The Cuyama River site was first occupied in 2009 but reported to me in April, 2010 by Bob Stafford, California Department of Fish and Game. The colony formed in cattails in a creek bed from which cattle had been excluded the year before. The John Smith Road site consists of a stand of milk thistle surrounded by open rangeland. The Boschma West colony was established in a triticale field adjacent to the existing West Poso location and reported to me by Keiller Kyle, Audubon California tricolored blackbird conservation coordinator. I discovered the Frog Pond and Main Canal colonies while surveying the nearby Ellsworthy site, which was unoccupied for the fourth straight year. The China Island South location is likely ephemeral and is believed to have been attractive to breeding tricolors in 2010 due to the combination of weedy substrate, availability of water (adjacent to the San Joaquin River), and plant foods in the form of stored grains at nearby dairies. The Bear Creek and San Felipe Ranch sites were detected and reported to me by Steve Simmons of Merced, who also provided access to these private and otherwise inaccessible ranches. The I-5 Right-of-Way colony adjacent to the I-5 northbound lanes three miles north of Santa Nella was detected while driving south on I-5 on the first day of field work in the southern San Joaquin Valley and is also likely an ephemeral location made attractive by a tall stand of milk thistle, a preferred nesting substrate, that resulted from the late, heavy, and persistent spring rains. The South Cackler site was detected during monitoring activities on Merced National Wildlife Refuge. The Conaway Ranch Berries site was reported to me by Roger Adamson, a Yolo Audubon member who was conducting Breeding Bird Survey (BBS) work on the ranch. Neither he nor Mike Hall, wildlife manager of the Conaway Ranch, had previously seen breeding tricolors at this location. The County Road and Kentucky Avenue site is likely also ephemeral and was reported to me by Keiller Kyle. The Highway 20 and Woodruff Lane site was originally reported by Rodd Kelsey to Keiller Kyle, who reported it to me. This location is part of an extensive stand of Himalayan blackberries that includes the Hallwood Road site. The Openshaw Road site, also in Himalayan blackberries, was reported to me by Altacal Audubon members after a note about these birds was posted to the Altcal Audubon listserve.

Colonies Destroyed by Harvest. No colonies were known to have been destroyed by harvest in 2010. I was informed of a settlement on a dairy adjacent to Merced National Wildlife Refuge but the triticale nesting substrate at this site was harvested during nest-building, before eggs were laid, in April, prior to my first day in the field (D. Woolington, pers. comm.).

Discussion

Reproductive Success. The reproductive biology of tricolors has been little-studied, and existing data are insufficient to determine whether the tricolor is more appropriately considered to be a "big bang" species where recruitment into the population results from infrequent, episodic bouts of relatively good productivity or a slow and steady breeder where recruitment results primarily from sustained, more uniform annual reproductive output. Most of the evidence that I have obtained over the past six years suggests that modest reproductive success, often much less than one fledgling per nest, is the norm, and that only in exceptional years or in exceptional locations is a larger colony, here defined as one consisting of 10,000 or more breeding birds, relatively successful at fledging young (fledges an average of one or more young per nest).

Table 4 summarizes the reproductive success estimates derived from the sampling of colonies for the past five years. In only five of these 18 colonies were one or more fledglings estimated to have been produced per nest, and overall, the RS for all 18 colonies over five years was 0.67 fledglings per nest.

Table 4. Tricolor Reproductive Success Estimates.

Colony Name	Substrate	Year	Number of Breeding Birds	Estimated RS
West Poso	triticale	2006	138,000	1.44
Homen Dairy	triticale	2006	70,800	0.85
Poso Creek	triticale	2007	50,000	0.006
Merced NWR East Farmfield	milk thistle, mustard	2007	65,460	0.14
Conaway Ranch Thistles	milk thistle	2007	35,000	0.91
Pioneer Duck Club	cattails	2007	58,800	0.95
Plumas-Arboga	cattails	2007	23,400	0.82
Delevan T43	cattails	2007	20,000	0.038
Costa's	triticale	2008	60,000	1.1
Riverview	triticale	2008	80,000	0.06
Plumas Arboga	cattails	2008	21,040	0.48
Costa's NE	triticale	2009	13,300	1.02
Costa's NW	triticale	2009	4,700	0.95
GMC	triticale	2009	31,500	1.05
Delevan T43	cattails	2009	75,000	0.26
Bear Creek	milk thistle	2010	83,000	1.44
Delevan T43	cattails	2010	53,000	0.25
Conaway Ranch	cattails	2010	18,900	0.42

The relatively low productivity of larger colonies extends throughout the Central Valley and appears to be independent of geographic region or substrate type. The relatively poor productivity of most larger colonies appears to result from a lack of insects in landscapes surrounding and within the approximately nine Km foraging radius of breeding tricolors. The "big bang" output of West Poso in 2006 and Bear

Creek this year were associated with 1) conspicuous insect outbreaks, and 2) foraging within one Km of colonies. The dearth of insects, required by females to form eggs (Ramsay and Houston 1998) and by nestlings during their first nine days of life (Crase and DeHaven 1977, Skorupa, Hothem and DeHaven 1980), is typical for landscapes surrounding the larger tricolor colonies as these are dominated by agriculture, and agricultural landscapes are, as a rule, poor tricolor foraging habitats (Hamilton and Meese 2006, DeHaven 2000). However, alfalfa (*Medicago sativa*) may provide excellent foraging substrate (Meese 2006) if unsprayed. The most extreme example of a large tricolor colony with low productivity may have been the Poso Creek colony in 2007, when a colony of 50,000 birds in a triticale field in Kern County abandoned the site approximately one week after the females built nests. Subsequent inspection showed that most nests were empty – the females had not laid eggs. A maximum of 200 young was produced from this colony (an RS of 0.006; Meese 2007).

Age Distribution. I believe that the sustained relatively poor reproductive success since 2006 is likely altering the age distribution of the species, from one dominated by younger age classes to one dominated by older age classes and that there are now proportionately more older birds in the population than there were in 2007, when the relatively large number of young produced in 2005 and 2006 likely resulted in a surge in recruitment into the population. The birds born in 2006 are now four years old and although there is an initial increase in fecundity with age, older females of most bird species show age-related decreases in fertility and increases in mortality (Loery et al. 1987). The statewide tricolored blackbird survey scheduled for 2011 may therefore show a decrease in the number of birds from the nearly 400,000 counted in 2008 (Kelsey 2008) and any age-related decreases in fecundity and increases in mortality may continue to reduce tricolor abundance until the next year of above-average reproduction.

Investments in Breeding Substrates. These considerations bear directly on investments in improvements at breeding sites. If these investments occur in areas where tricolor colonies have a history of low productivity, they may encourage nesting attempts by many thousands of birds but result in the production of relatively few young. This is because the landscape within the fixed foraging radius of a tricolor will produce some maximum number of insects for breeding birds, and as the number of birds to be supported on this fixed insect population increases, the number of insects available to each nestling decreases, likely resulting in decreases in per-nest reproductive success. Under such circumstances, most nestlings (assuming that eggs are produced and hatched) are likely either to be brood-reduced by females or starve to death. In the case of the southern San Joaquin Valley, investments in breeding substrates may help to solve the problem of conflicts with crop harvest by moving breeding birds off of vulnerable triticale substrates and on to secure emergent marsh substrates but do little to add to productivity as the surrounding landscape offers low insect abundance. In southern California, it may be essential to try to conserve the few remaining tricolors through efforts aimed at securing the few remaining nesting substrates. The Holiday Lake marsh in northwestern Los Angeles County and Hemet Water Treatment marsh in Riverside County are two examples where intensive management, including thorough monitoring that documents the fates of colonies, may help to conserve breeding but where surrounding foraging habitats are too poor to expect much productivity. Likely, nearby Audubon members, or in the case of Holiday Lake, property owners, could be enlisted to monitor the sites, especially if they were provided some guidance in how and when to monitor, and report on settlements, numbers of breeding birds, and numbers of young seen.

Kern NWR Colony. The colony at Kern NWR was something of a surprise as although this site has historically supported tricolor colonies, it has not been occupied by breeding tricolors since 2004. During this interval, management actions by Kern NWR staff have been consistent (D. Hardt, pers. comm..) and the cattail (*Typha* spp.) substrate has been maintained in the condition preferred by nesting tricolors (pers. obs.). Nearby insect populations were not conspicuously larger nor smaller than in recent years.

One possible explanation for the use of Kern NWR may be that the birds responded to recent changes in some crop rotations on farms to the east of the Refuge where fields formerly planted to triticale have recently been planted to wheat or other grains not attractive to nesting tricolors, thus reducing the amount of off-Refuge nesting substrate.

New Nesting Locations. There was again in 2010 a relatively large number of new nesting locations (colony sites) documented, including the year's largest and most productive colony (Bear Creek, Merced County). It is likely that the late, heavy, persistent rains in April and May of 2010 supported the growth of vegetation that was attractive to nesting tricolors this year, as six of the 14 new locations were dominated by milk thistle, a preferred nesting substrate that varies widely in abundance and height from year to year in response to late-season precipitation (pers. obs.).

Since 2005, a total of 70 new colony locations has been documented. The continued discovery of new colony locations results from annual detection efforts through on-the-ground surveys of appropriate habitats, outreach efforts to field personnel, and reports of new colony locations received via the tricolored blackbird portal. A more thorough knowledge of breeding colony locations helps both to assess the results of annual breeding efforts and to increase the accuracy of triennial statewide population estimates and is essential for comprehensive monitoring efforts.

Insect Outbreaks. The relatively high reproductive success of the Bear Creek colony was believed to be a response to an abnormally high abundance of grasshoppers. Grasshoppers are favored foods of tricolors (Crase and DeHaven 1977, Skorupa, Hothem, and DeHaven 1980; pers. obs.) and foothill locations experienced a grasshopper outbreak in 2010 (Reiter 2010). The Bear Creek colony was located in an unusually tall, vigorous stand of milk thistle surrounded by open pasture; grasshoppers were observed in great abundance during monitoring activities. The reproductive success of this colony in 2010 confirmed the theory of brood reduction, whereby females reduce the number of nestlings that they will attempt to rear during periods of food scarcity by removing nestlings and disposing of them at the periphery of colonies. The theory of brood reduction predicts that in times of abundant food resources, females will not reduce their broods (Lack 1947, 1954). At the Bear Creek colony, brood-reduced young were searched for but not found. The results observed at this site this year are consistent with the results from Poso 1 in 2005 and West Poso in 2006 and taken together strongly suggest that insects may limit tricolor productivity in most locations in most years and that maximum tricolor productivity occurs when relatively high insect abundance is found in close proximity to tricolor colonies.

Storms. Although storms occur every year and affect productivity of colonies established in a variety of substrates, the relatively consistent, late storms during April and May of this year produced conditions that resulted in unusually vigorous growth of milk thistle, a preferred nesting substrate. The milk thistle, however, proved to be an especially vulnerable nesting substrate as the strong winds associated with the late spring storms were believed to have damaged three colonies in Merced County. The Merced NWR Duck Slough second nesting, which was visually estimated to have involved approximately 15,000 breeding birds, was virtually wiped out during a single storm event on May 20. The same storm severely damaged the San Felipe Ranch colony, two miles northwest of the Duck Slough colony, where I observed hundreds of dead nestlings on the ground beneath the nests, and caused hundreds of nests in the Bear Creek colony to be tilted sideways, resulting in losses of eggs and nestlings (Figure 1).

Condition of Nests. The impacts of insufficient food can be manifest in several ways. The most dramatic impact of insufficient food is starvation, an impact that is rarely observed in adult birds but may be more readily observed in nestlings, as was the case in Delevan T43 this year. A less dramatic impact may be manifest in an inability of females to lay eggs, as female require sufficient quantities of amino acids and essential fatty acids to form eggs (Carey 1996). A comparison of Tables 2 and 3 shows that colonies with low RS estimates have proportionately more immaculate nests than do those with relatively high RS estimates. This pattern is consistent across sites and suggests that a higher proportion of breeding females in relatively insect-poor landscapes are unable to form eggs than are those in more insect-rich landscapes and the proportion of immaculate nests may provide a barometer of reproductive performance.

Starvation. The observations of apparently starved nestlings at Delevan T43 documented for the first time this source of nestling mortality. In most cases, brood reduction, is believed to bring the number of nestlings into line with what adult birds may successfully rear to fledging (Lack 1947, 1954). The relatively larger number of emaciated nestling carcasses in the west end of the Delevan colony may be difficult to interpret but may suggest that foraging efforts were particularly unsuccessful for the last birds to arrive, as relatively fewer emaciated carcasses were found in the eastern and middle portions of the colony (the first and second portions to settle). It is also possible that fewer eggs were laid by early-arriving females, and that the lower rate of apparent starvation observed in the eastern and central portions of the colony was due to a relatively smaller number of young produced per nest. Starvation is suspected as the cause of the observed nestling mortality because the weather during the early summer of 2010 was unusually moderate and weather-induced mortality should have been minimal during the nestling interval at Delevan.

Black-crowned Night Herons. Black-crowned night herons (*Nycticorax nycticorax*) have in the recent past been cited as causing widespread losses due to predation on eggs and nestlings of tricolors (e.g., Hamilton and Meese 2006). Black-crowned night herons occurred in low abundance in or immediately adjacent to most colonies in wetland habitats in 2010 but in much greater abundance at Conaway Ranch, Yolo County, where 10-30 individuals were observed daily during banding activities. In no instance was predation upon eggs or nestlings of tricolors by night herons observed, although the young at Conaway were fledging during the period of trapping and banding and predation events would have been relatively conspicuous and readily observed. The night herons observed at Conaway Ranch were apparently breeding at a large heronry three miles south of the tricolor colony and although consistently present in relatively large numbers, were observed to prey only upon California voles (*Microtus californicus*), which occurred in exceptionally great abundance. Thus, this year extends to at least five years the interval during which predation by black-crowned night herons was not known to seriously affect tricolor reproduction at any colony in the Central Valley and what a short time ago appeared to be a serious threat to the species' survival (Hamilton and Meese 2006) now appears to have no detectable impact on larger tricolor colonies in the Central Valley.

Recommendations for Conservation

The conservation of tricolored blackbirds will require the efforts of public land managers as well as an informed, sympathetic network of private property owners, to sustain the species on California's human-dominated landscapes. The following are recommendations for conservation actions that are needed to sustain the species:

1. There is a need for immediate investments in secure nesting substrates surrounded by secure, productive foraging habitats. This may be the most essential conservation action yet also the one least likely to occur unless substantial sums of money are obtained for its implementation. As discussed in this and previous reports (DeHaven 2000, Meese 2007), tricolor productivity may now be limited more by foraging habitat (and by cattle egret predation; see item 3, below) than by breeding habitat, as most Central Valley colonies exist

as tiny semi-natural islands in an expansive sea of agriculture, while those in southern California are typically islands in seas of urbanization. Where opportunities exist for the long-term conservation of nesting habitats surrounded by secure, productive foraging habitats, these should be immediately pursued and secured. Where possible, it may be worthwhile to investigate the possibility of enhancing populations of insects preferred by foraging tricolors in habitats surrounding and within nine Km of nesting substrates. These investments are essential to conserve tricolor breeding efforts in both southern California and the Central Valley.

2. The shooting of birds in the Sacramento Valley must stop. The shooting of breeding and post-breeding adult tricolors, prohibited under the Migratory Bird Treaty Act, continues and is not only illegal, it runs directly contrary to the voluntary efforts made by members of the Tricolored Blackbird Working Group and its many collaborators to stem the decline of the species. Assuming that most or all illegal shooting results from a lack of awareness on the part of property owners and perhaps some agency staff, additional efforts to educate property owners and their employees, relevant county, state, and federal agency staff, and industry representatives should immediately be undertaken. These efforts must incorporate assistance from industry, especially the California Rice Commission, and county agriculture representatives, and must stress the difficulty in discriminating red-winged blackbirds (*Agelaius phoeniceus*), which may legally be shot, from tricolors, which are protected and cannot be shot. Education and outreach efforts must include recommendations for how to humanely and effectively deter blackbirds, not only tricolors, from feeding on ripening rice, as hazing or otherwise preventing blackbird depredation is preferred over shooting because most farmers and field workers will be unable to discriminate between the two similar-in-appearance blackbird species. Where these efforts prove to be insufficient to prevent the illegal shooting of tricolors, law enforcement officers must take appropriate actions.

   Alternatively, existing federal law should be changed to make illegal the shooting of all blackbird species in the Central Valley due to the similarity in appearance between the protected tricolor and not protected red-wing. Education and outreach efforts assume that farmers and their employees will be able to discriminate between two nearly identical species and to refrain from shooting one while shooting the other. It may be unrealistic to assume that non-specialists (farmers and their employees) will successfully discriminate between these two species and effective conservation may require the full federal protection of both species where their ranges overlap.

3. Eliminate cattle egret predation from the southern San Joaquin Valley. The severity of the impacts of cattle egret predation on tricolor productivity in the southern San Joaquin Valley increases annually and in 2010 resulted in the complete reproductive failure of 3 large colonies in Tulare County. The options for controlling cattle egret predation are few, but assuming cultural transmission between adult cattle egrets and their young (i.e. that adult cattle egrets teach their young that tricolored blackbird colonies provide a bountiful and easily accessible food resource), the problem can only be expected to get worse and to spread to other geographic regions. Immediate actions must be taken to reduce the incidence of cattle egret predation on tricolor eggs and nestlings.

4. Continue annual detection and monitoring of tricolor colonies in both southern California and the Central Valley with an emphasis on determining the fates of the largest colonies. It is insufficient to document presence and absence and to visually estimate the number of

breeding birds at occupied sites as effective conservation of the species is dependent upon a knowledge of the factors that result in specific reproductive outcomes – successes as well as failures, as these will help to discriminate among conservation alternatives.

5. Form active collaborations with water agencies. Many present and former tricolor colonies have been located on properties managed by water agencies, and many of these have supported significant numbers of breeding birds (e.g., Toledo Pit in Tulare County, Kern Water Bank in Kern County, Hemet Water Treatment Plant in Riverside County, Holiday Lake in Los Angeles County, Sweetwater Reservoir in San Diego County). The support of southern California water agencies is especially important if the tricolor's southern California population segment is to persist. Water agencies ought to be informed of the roles that the habitats that they provide play in regional conservation efforts and relationships must be established whereby U.S. Fish & Wildlife Service and/or California Department of Fish and Game staff, or their designees, can, at a minimum: 1) access water agency-controlled sites for tricolored blackbird survey and monitoring efforts, 2) evaluate current conditions of potential tricolor nesting substrates, and 3) make recommendations for management activities that are intended to benefit breeding tricolors and other wetland-dependent species. Formal agreements for access as well as for consultations on best management practices for breeding tricolors would be most beneficial, but any type of agreement that ensures access and establishes frequent dialogue may significantly enhance tricolor conservation on water district properties.

6. Continue annual, large-scale banding to inform researchers and land managers about tricolor life history traits and movement patterns, especially as regards the documentation of linkages among breeding colonies. We know very little about basic life history attributes of tricolors and given the success of the first four years of banding, we stand to learn much about longevity, age-specific rates of mortality, and spatial and temporal patterns of movement.

7. Support the establishment of a program to compensate landowners who, despite efforts to deter foraging by tricolors, can demonstrate losses due to tricolored blackbird depredations. Tricolors may cause financial hardship for some farmers in both the San Joaquin and Sacramento Valleys. Existing programs seek to compensate some of the farmers in the San Joaquin Valley who incur losses when tricolors nest in their grain fields. This program should be expanded to include rice farmers in the Sacramento Valley who can demonstrate that losses to their rice crops are directly attributable to tricolor depredation. The establishment of such a program may help to reduce the anxiety of some farmers to a doubling of the population of tricolors, as called for in the Tricolored Blackbird Conservation Plan (TBWG 2007), and complement education and outreach efforts.

8. Develop a catalog of priority areas for conservation. This may be a web-based catalog that identifies specific sites, actions, and funding that are required to conserve at-risk tricolor breeding and wintering sites from destruction or encroachment. Records for sites in the catalog should have complete geographic and contact information, photographs that document site characteristics, descriptions of what is known about the history of tricolor use and of the nature of the threats to the site, specific recommendations for actions needed to protect the site, an estimate of the funding that would be necessary to implement the suggested actions, a list of agencies and persons who are responsible for implementing and monitoring conservation actions, and a summary of expected benefits to local, regional, or statewide tricolor populations. The records in the catalog should be updated to reflect

successes and failures of conservation actions and recommendations for changes or additional actions.

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Appendix 1 Characteristics and Fates of Tricolor Settlements and Colonies Detected in 2010.

Colony Name	County	Substrate	Date Detected	Detected By	Area Occupied (Ac)	Number of breeding birds	Comments
Cuyama River	San Luis Obispo	cattails	unknown	Stafford	.5		
John Smith Road	San Benito	milk thistle	5/6/2010	K. Crouch	.5	1,000	
Costa's	Kern	triticale	unknown	Frazer	66	66,000	
ECLA Ponds	Kern	cattails and bulrush					
Kern NWR	Kern	cattails and bulrush	unknown	Frazer/Hardt	20	20,000	not occupied since 2004
Boschma West	Kern	triticale	unknown	Frazer	2	500	new location
Bear Creek	Merced	milk thistle	5/2010	Simmons/Meese	8	83,000	new location; large, productive colony
Hulen Levee	Merced	Himalayan blackberry	5/7/2010	Meese	1	25,000	relatively productive
Merced NWR Duck Slough	Merced	mustard and milk thistle	unknown	Albers/Woolington	5	15,000	2 settlements; 2nd destroyed by storm
Frog Pond	Merced	cattails and bulrush	5/13/2010	Meese	10	10,000	new location
Main Canal	Merced	bulrush and cattails	5/13/2010	Meese	1	800	new location
China Island South	Merced	mustard, milk thistle	5/13/2010	Meese	2	700	new location
San Felipe Ranch	Merced	milk thistle	5/27/2010	Simmons/Meese	4	2,000	new location; mostly destroyed by storm
I-5 ROW	Merced	milk thistle	5/7/2010	Meese	2	500	new, aberrant location along I-5 northbound
South Cackler	Merced	cattails, bulrush	6/15/2010	Meese	2	1,000	new location; failed
Owens Creek	Merced	milk thistle, mustard	unknown	Simmons	25	15,000	mostly destroyed by sheep grazing

Crane Ranch	Merced	Himalayan blackberry	unknown	Simmons	5	2,000	much evidence of predation
Conaway Ranch Berries	Yolo	Himalayan blackberry, willow	5/2010	Adamson	1	500	new, aberrant location
Conaway Ranch	Yolo	cattails, bulrush	6/10/2010	Meese	11.5	18,900	moderately productive
CR 102 and Kentucky Ave.	Yolo	mustard, milk thistle	unknown	Kyle	5	3,000	new, aberrant location; low productivity
Hwy. 20 and Woodruff Lane	Yuba	Himalayan blackberry	unknown	Kelsey	2	unknown	new location
Plumas Arboga	Yuba	cattails, bulrush	6/4/2010	Meese	4	7,000	failed
Quartz Hill Detention Basin	Los Angeles	cattails	4/10/2010	Rouzer	1	200	reported via email
Quail Lake	Los Angeles	cattails	4/10/2010	Rouzer	2	500	reported via email