Enhancement of Tricolored Blackbird Breeding Habitat at the San Jacinto Wildlife Area

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INTRODUCTION

The tricolored blackbird (*Agelaius tricolor*) is a medium-sized songbird of the family Icteridae and a sister species of the red-winged blackbird (*A. phoenicius*). A near-California endemic, with 95% of its historic breeding range within the state, the tricolored blackbird holds the distinction of forming the largest breeding colonies of any North American passerine since the extinction of the passenger pigeon (*Ectopistes migratirius*). Colonies as large as 300,000 adult birds were reported in the past (Neff 1937). During the 19th century, Baird et al. (1874) described the tricolored blackbird as “the most abundant species near San Diego and Los Angeles Counties.” Collier (1968) and DeHaven et al. (1975) estimated the population to be approximately 1.5 million in the mid-1930s, but only half that number 40 years later (DeHaven 1975). Further dramatic declines are evident from data collected between 1994 and 2000 (Cook and Toft 2005). The last statewide survey, the most intensive to date, documented 150,000 individuals (Meese 2014), 12,386 of which were in southern California.

Taxonomic Status

The tricolored blackbird is geographically distributed in two population segments, the California Central Valley and southern California. The southern California population is considered to be the most at-risk and rapidly declining (Tricolored Blackbird Working Group 2007). Historically, the two populations were assumed to be genetically isolated between the north and south by the Tehachapi Mountains. However, in the only population genetic study done to date on this species, Berg et al. (2010) found no evidence of significant population structuring, which they interpreted to suggest either considerable movement between north and south or that isolation is very recent and is not yet reflected in the population genetic signatures. At the same time, they found a higher allelic diversity in the southern California population, which suggests it represents an important reservoir of genetic variation for the species overall. More recently, Meese (2011) documented a tricolored blackbird that was banded in the Central Valley and re-sighted in the Newberry Springs area of San Bernardino County south of the Tehachapi Range. Further, a 120% increase in the number of birds observed in this area and northern Los Angeles County during a census conducted in 2014 compared to one three years earlier (Meese 2014) was almost certainly due to immigration from the Central Valley. However, there is no evidence of immigration from the Central Valley into southern California south of the Transverse Ranges. Ideally, another population genetic study would address this question specifically.

Habitat Characteristics

Prior to the agricultural development of California’s Central Valley and the urbanization of southern California, tricolored blackbirds nested predominantly in freshwater and estuarine marshes where nests were built over water in mature stands of cattail (*Typha* spp.) or bulrush (*Scirpus* or *Schoenoplectus* spp.). At least half of colonies statewide now utilize a diverse array of wild upland habitats and agricultural areas, primarily dairies. Tricolored blackbirds nest in emergent freshwater marsh, undeveloped upland habitats, and agricultural fields (Beedy 2008). Nesting substrate in natural upland areas often consists of spiny or otherwise protective plant species including Himalayan blackberry (*Rubus armeniacus*), California wild rose (*Rosa californica*), thistle (*Silybum* spp., *Cirsium* spp.), stinging nettle (*Urtica dioica*), elderberry (*Sambucus* spp.), and western poison oak (*Toxicodendron diversilobum*) in pure or mixed stands with other vegetation. However, use of other species such as willows (*Salix* spp.), mule fat (*Baccharis salicifolia*), mustards (*Brassica* spp.), cheeseweed mallow (*Malva parviflora*), and giant cane (*Arundo donax*) also occurs (Beedy and Hamilton 1999). In Riverside County as in much of the San Joaquin Valley, agricultural nesting occurs primarily in triticale (*Triticale hexaploide*), a wheat/rye hybrid grown on dairy farms as silage for dairy cattle (Cook and Toft 2005, Biological Monitoring Program 2013).

Adult tricolored blackbirds feed on grain and insects throughout the year. Young up to nine days old depend entirely on insects and other invertebrates gathered from fields of native and non-native forblands and grass/forbland mixtures, irrigated pasture, lightly grazed rangeland, dry season pools, mowed alfalfa (*Medicago sativa*) fields, and various scrub vegetation associations. Tricolored blackbirds are considered generalist predators and the most important prey for their nestlings include beetles, grasshoppers, locusts, caterpillars of butterflies and moths, true bugs, and arachnids (Crase and DeHaven 1977).

Ideal foraging conditions are created when shallow flood-irrigation, mowing, or grazing keeps the vegetation at an optimal height (<6 in.) for tricolored blackbirds (Beedy 2008). Such conditions are found in alfalfa grown as forage for dairy cattle. Alfalfa is superior in the production of insects that normally must be managed as pests in growing operations (Smallwood and Geng 1993, Putnam and Kaffka 1995). Tricolored blackbirds frequently nest at dairies because they provide adults with all of their necessary resources for raising their broods, including an abundance of grain, insect-productive foraging habitat, nesting substrate (triticale), and a fresh water supply, all in close proximity.

Population Demographics

The Central Valley population of tricolored blackbirds exhibits both seasonal migration and itinerate breeding behavior whereby birds nest multiple times during a season but in different parts of their range, whereas the southern California population exhibits neither of these characteristics (Beedy and Hamilton 1999).

Breeding occurs from early March to early June in most parts of the state but can continue as late as September in the northern part of the Central Valley. A complete nesting cycle lasts about 45-50 days (Beedy and Hamilton 1999). This includes a period of settlement and territory establishment of 5–7 days, nest-building and egg laying over about 5 days, and incubation for 11–14 days. Average clutch size is three eggs per nest. Females construct the nests, very rarely with help from males, and incubate the eggs. Male birds often spend large parts of the day away from the colony during incubation, often in all-male flocks, and return after eggs have hatched. Chicks fledge at 12–14 days of age and continue to be fed by their parents for another 10 days. Post-fledging juveniles from a single colony often gather into a flock known as a cresh.

Nests are built within small territories that are usually adjacent to one another occupy a few square meters or less. Territories include one male and 1–3 females. Timing of nesting within a colony is often highly synchronous. However, a single colony can include birds at different stages in the nesting cycle if settlement by independent flocks occurs at different times. Foraging behavior is highly social and both sexes provision young. Foraging can occur up to 5 miles from the nest site but is usually within 0.5–1.5 miles. Colonies often disperse after the breeding season and individuals may join mixed flocks of songbirds, primarily other species of blackbirds, European starlings (*Sturnus vulgaris*), and brown-headed cowbirds (*Molothrus ater*). Banding studies, summarized by Neff (1942) and DeHaven and Neff (1973), suggest that tricolored blackbirds can live for at least 13 years. Data from more recent banding studies indicate annual adult survivorship to be about 60% (Meese 2013), similar to that of red-winged blackbirds (Nero 1984).

Food limitation and nest predation have long been considered the most important factors regulating avian productivity (Lack 1954, Martin 1993). Rates of nestling survival and reproductive success are associated with the selection of nesting substrates in tricolored blackbirds (Cook and Toft 2005), presumably due to the mediating effect of protection conferred by them. Reproductive success is significantly higher among colonies using Himalayan blackberry, a well-armored species, than either emergent vegetation or triticale, and significantly higher among colonies using triticale versus emergent vegetation (Cook and Toft 2005). The most important predators of marshland colonies include black-crowned night-herons (*Nycticorax nycticorax*), coyotes (*Canis latrans*), and cattle egrets (*Bubulcus ibis*) (Beedy and Hamilton 1999, Meese 2012). However, destruction of nesting colonies by other predators has been well-documented and includes northern harrier (*Circus cyaneus*), Swainson's hawks (*Buteo swainsoni*), Cooper's hawks (*Accipiter cooperii*), burrowing owls (*Athene cunicularia*), American crows (*Corvus brachyrhynchos*), raccoons (*Procyon lotor*), mink (*Mustela vison*), skunks (*Mephitis* spp.), barn owls (*Tyto alba*), short-eared owls (*Asio flammeus*), yellow-billed magpies (*Pica nuttallii*), and feral cats (*Felis catus*) (Beedy and Hamilton 1999). Tricolored blackbirds do not exhibit strong defenses against predators, such as mobbing behavior, and complete reproductive failure in colonies of thousands of birds can result from the efforts of relatively few predators (Beedy and Hamilton 1999).

Although nest predation is a major cause of nest failure in tricolored blackbirds, evidence suggests an important role of food limitation as well. Complete failure of breeding colonies has been observed when nearby alfalfa fields were plowed (Liz Cook, California Department of Water Resources and Robert Meese, University of California, Davis personal communications). In arid and semi-arid ecosystems, such as in southern California, the timing and amount of annual rainfall influences reproductive output in birds (DeSante and Geupel 1987, Grant et al. 2000, Morrison and Bolger 2002). Recently, Meese (2013) documented chronically low reproductive success of tricolored blackbirds in the Central Valley associated with low insect abundance. The cause is unclear although drought, the intensive use of pesticides, and new products such as neonicinoid pesticides (Robert Meese personal communication, Mineau and Palme 2013) in recent years are possible explanations.

Conservation Status

The decline of the tricolored blackbird over the last 20 years has been documented by coordinated statewide surveys that have been conducted every three years since 1997, with a break between 2000 and 2005 (Meese 2014). A statistically balanced reduced survey effort for intervening years began in 2015. The tricolored blackbird was classified as Globally Endangered by the International Union for Conservation of Nature (IUCN) Red Data List since 2008 (Birdlife International 2012). Following results of the most recent statewide survey in 2014, the species was granted an emergency Endangered Species listing by the state of California, and this protection expired in June 2015. A petition for full listing was submitted in August 2015 and the species became a candidate the following December. A federal petition for Endangered Species status is currently under review.

The species is one of 45 bird species covered by the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) (Dudek & Associates 2003). Species-specific habitat Core Areas designated by the Plan for the tricolored blackbird include Mystic Lake/San Jacinto Wildlife Area, San Jacinto River Floodplain, Collier Marsh/Lake Elsinore Grasslands, Northwest Alberhill, and Vail Lake/Wilson Valley/Eastern Temecula Creek. Of these, tricolored blackbird colonies have been documented only in the Mystic Lake/San Jacinto Wildlife Area and Vail Lake/Wilson Valley/Eastern Temecula Creek core areas. Tricolored blackbirds are covered under a number of other Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs) including those that cover parts of Yolo, Contra Costa, San Joaquin, Sacramento, and San Diego Counties, the East Bay Regional Park District, Santa Clara Valley, Alameda Watershed, Tehachapi Uplands, and Imperial Irrigation District in San Diego County.

Population Status in the MSHCP

The tricolored blackbird population has declined by 75% in western Riverside County since the MSHCP was established in 2004 and is currently at serious risk of extirpation in southern California (Biological Monitoring Program 2013). The San Jacinto Valley remains the most important center for reproduction in southern California south of the Transverse Range, as supported by the results of five of the six intensive statewide surveys for tricolored blackbirds since 1997 that have documented that 51–93 percent of the breeding population occurred within there. Since 2004 and prior to the implementation of this project, nesting occurred most frequently on nearby dairy farms where an entire year’s effort could be destroyed in a single harvest, as occurred in the spring of 2013 (Biological Monitoring Program 2014). In years of drought, such as 2006, reproductive effort can be non-existent (Paulek and Nash 2007).

Conservation of the tricolored blackbird within the MSHCP Plan Area will require the enhancement of secure breeding and foraging habitats. Conservation actions, summarized by Birdlife International (2012), include breeding habitat protection and management, habitat and natural process restoration, awareness and communication, and legislative protection at the national level.

Project Goals and Objectives

The goal of this project is to help stabilize and rebuild the population of tricolored blackbirds within the MSHCP Plan Area. Primary objectives are to:

1) Investigate the feasibility of enhancing breeding habitat for the tricolored blackbird in the San Jacinto Wildlife Area;
2) Evaluate the effectiveness of project sites in attracting tricolored blackbird breeding colonies;
3) Reduce the incidence of nesting at dairy farms in the San Jacinto Valley;
4) Achieve levels of reproductive success at project sites exceeding the replacement rate of adult birds; and
5) Fill critical knowledge gaps in habitat selection and resource use, particularly preferences among upland nesting substrate types and attractive densities of invertebrate prey essential to conserving this species in this and other NCCPs/HCPs in California.

A secondary objective is to assess the use of habitat enhancement sites by other sensitive avian species that share similar resource requirements with the tricolored blackbird. These include any species listed under the federal or California Endangered Species Acts, California Species of Special Concern such as the burrowing owl, long-billed curlew (*Numenius americanus*) and yellow-headed blackbird (*Xanthocephalus xanthocephalus*), other species tracked by the California Natural Diversity Database, and species covered by the MSHCP such as California horned lark (*Eremophila alpestris actia*), loggerhead shrike (*Lanius ludovicianus*), grasshopper sparrow (*Ammodramus savannarum*), and Swainson's hawk (*Buteo swainsoni*).

METHODS

The strategy for achieving these objectives was the co-location of secure nesting substrate with insect-productive forage crops and natural grasslands. Methods included the establishment of agricultural crops used by tricolored blackbirds for nesting and foraging at dairy farms along with some types of perennial native shrubs and forbs used in natural areas. Two types of foraging habitat were experimented with: 1) alfalfa grown to maximize insect production, and 2) irrigated upland grass/forbland. Alfalfa is a perennial species that can grow for up to six years without replanting. Triticale, an annual cultivar that grows to maturity in about 120 days, was planted in both years of this project to provide substrate for nesting each spring. Two native perennial species that would provide superior nesting substrate but take longer to develop were also planted: stinging nettle (*Urtica dioica*) that would reach maturity within 2 or 3 years and California wild rose (*Rosa californica*) that would require about 4 years to form a dense thicket but could persist for 20–30 years.

Study Site

The Davis Unit of the San Jacinto Wildlife Area (Wildlife Area), is a 10,000-acre state-owned wildlife area managed by the California Department of Fish and Wildlife (CDFW) and it supports a high diversity of bird species, several rare and endangered plant species, habitat for the endangered Stephen's kangaroo rat (*Dipodomys stephensi*), and many other species covered by the MSHCP (Fig. 1). The Wildlife Area supports 900 aces of managed ponds and wetlands, with the balance consisting of grass/forblands at lower elevations, and Coastal Sage Scrub communities on hillside slopes. Grass/forblands are dominated largely by non-native plant species. Grain and seed crops are grown in some years on a small scale to support wildlife and upland game bird species. Soils are predominantly alkaline with a heavy clay component. The Wildlife Area is bounded by the Lake Perris State Recreation Area to the west and Badlands to the north. Private lands to the south and east are used primarily for agriculture, mainly dairy farming. There are three dairy farms on the boundaries of the Wildlife Area. The Wildlife Area and dairy farms receive reclaimed, tertiary treated water from the Eastern Municipal Water District (EMWD).

The Wildlife Area is widely recognized as an important stopover for migratory waterfowl, a haven for over-wintering raptors, and a critical breeding area for the tricolored blackbird. For these reasons, the refuge stands as a central feature of the San Jacinto Valley Important Bird Area (Cooper 2014). Prior to 2005, the Wildlife Area supported some of the largest tricolored blackbird colonies in southern California since record keeping began in 1994 (Biological Monitoring Program 2011). However, since 2005, and prior to the initiation of this project, nesting occurred only once, in 2011, by a small 400-bird colony.

Project sites were located near the southern and eastern boundaries of the Wildlife Area. Site 1 included approximately 80 acres of cleared land immediately north of the Bridge Street Pond reservoir. The entire site was bordered by large open fields to the south, Mystic Lake to the east, the private Four Winds Pheasant Club to the west, and several large duck ponds to the north. Mystic Lake is a large natural ephemeral waterbody that fills with water only in exceptional rain years. The most recent event occurred in the winter of 2010-2011. The lake held water through most of 2012 but has been dry since. Vegetative cover on the pheasant club was maintained in a natural state for many years prior to the winter of 2014 when it was planted with triticale. The field was replanted with this crop again in the winter of 2015.

F**igure 1.** The Davis Unit of the San Jacinto Wildlife Area. Wildlife Area boundaries are marked in white, project sites in yellow, and Four Winds Pheasant Club in red.

Site 1 was prepared for growing crops in the years preceding this project, with leveling and tilling the land, and the construction of earthen levees around it. The reservoir supports a ratio of emergent vegetation to open water of about 50:50 in most years. Emergent vegetation is primarily narrowleaf cattail (*Typha angustifolia*) and, secondarily, hardstem bulrush (*Scirpus acutus*). The upland area of Site 1, adjacent to the pond and part of the project site, supported tricolored blackbird colonies multiple times in the past with the earliest record of occurrence, to our knowledge, in 1994. Nesting substrate is described as stinging nettle in some of these accounts. The most recent colony to nest at this site, in 2011, occupied an area of about 3 acres which was covered by stinging nettle and bull thistle (*Cirsium vulgare*). In the fall of 2011, all vegetation was removed from the field and was maintained as bare ground until the initiation of this project. Nesting in the emergent vegetation at this site has not been documented in the records available to us; however, most of this information is incomplete.

Site 2 is a 40-acre parcel of level land located approximately 0.25 miles west of Site 1. Land use prior to the initiation of this project was the production of grain crops; however, it was fallow for two years before the project began. Fertilizer was applied in the form of cattle manure. A subsidence crack runs north to south almost the entire length of the field, with a depth at its lowest point of approximately 10 feet. This site is bordered by a 4-acre pond supporting emergent vegetation similar to that at Bridge Street Pond, and open fields, maintained in a natural state, to the south and west. The pond is owned by the Little Ramona Duck Club but is under a conservation easement with CDFW. There are several other larger duck ponds within 2 miles to the north and east. The Spring-Summer Wetlands, a reverse-cycle wetland managed as nesting habitat for tricolored blackbirds and waterfowl, are 1.75 miles from Site 2.

This project was carried out between April 1 of 2014 and March 31 of 2016. Year One of the project occurred March 1, 2014 – March 31, 2015 and Year Two occurred April 1, 2015 – March 31, 2016.

Project Site Development

Year One

Development at Site 1 began on March 24, 2014 with the installation by the EMWD of an 8-inch water line and two valves to provide water to the field and to Bridge Street Pond. The 80-acre field was plowed and leveled between late summer and early fall of 2014 using a John Deere 5510 tractor, Cannon box scraper, and 1312 John Deere carry-all, then subdivided into sections for planting with earthen levees between sections (Fig. 2). An existing levee along the eastern border of the field was reinforced to ensure that no reclaimed water entered Mystic Lake per EMWD requirements. At the time the grant proposal was submitted, 30 acres was allocated for the planting of triticale and 35 acres for alfalfa. Subsequently, Wildlife Area staff extended the field another 5 acres to the north. After the levees were built, Site 1A (triticale field) was 34 acres and Site 1B (alfalfa field) was 41 acres as measured from Google Earth imagery. Sites 1C and 1D were 2.5 acres each.

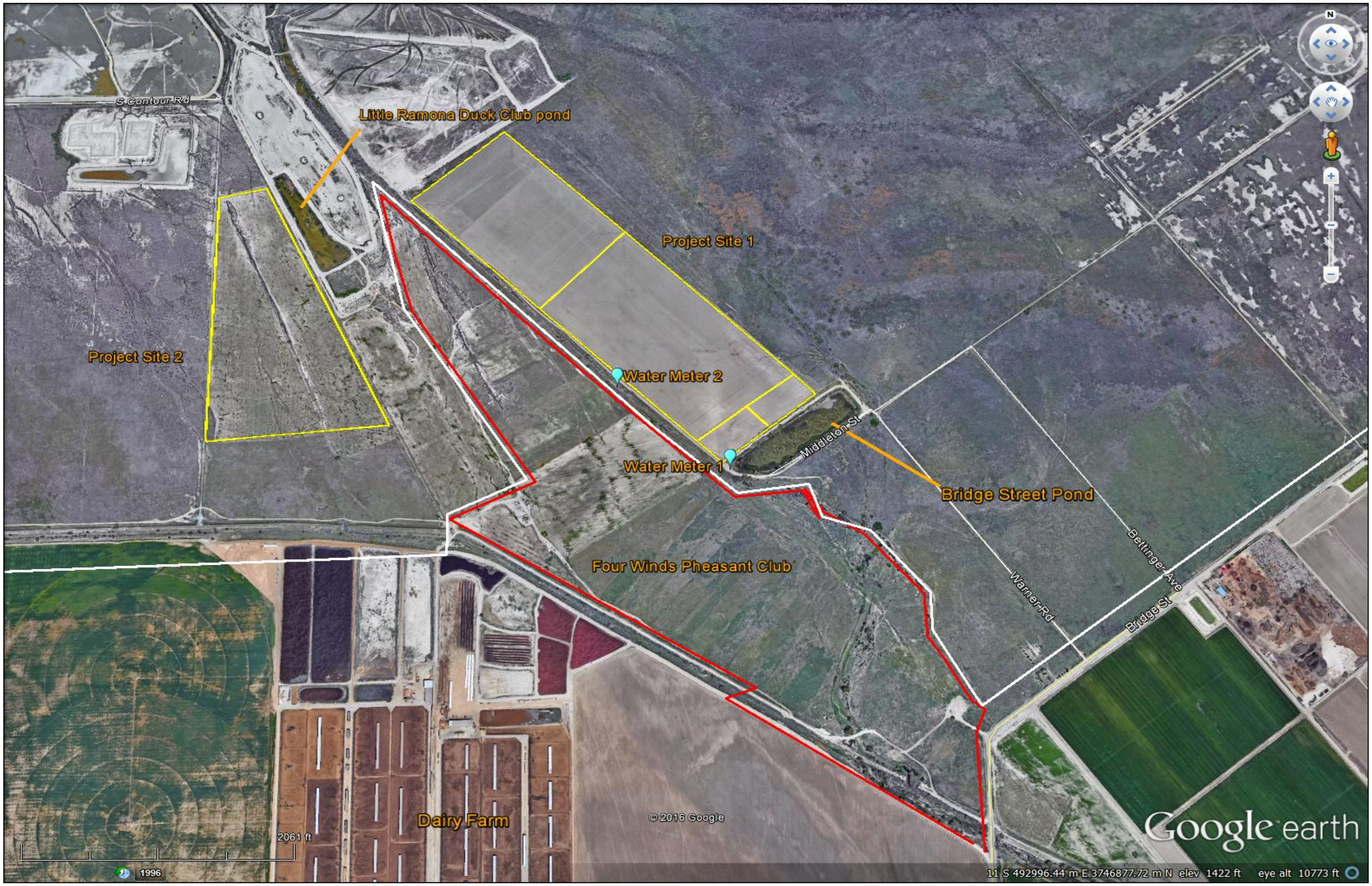

Figure 2. Project sites showing subdivisions and metered water valves at Site 1.

A channel was constructed along the western length of the field to deliver water from the metered valve at Bridge Street Pond through furrows running in a perpendicular direction across Sites 1A and 1B. Water spilled from the end of a single pipe connected to one of the valves into the channel along Site 1D and flowed to 1A and 1B. Five concrete flash board water control boxes (Fig. 3) were installed to help control water delivery between sites. One control box released water into 1D and another from 1D into 1C. Two other boxes drained excess water from 1C and 1D into 1B. The fifth box controlled water movement within the main channel between Sites 1A and 1B.

Thirty acres of triticale was planted at a density of 23 pounds per acre at Site 1A using a seed drill. Thirty-five acres of alfalfa was planted by broadcast seeding at 30 pounds per acre at Site 1B in the second week of December 2014. Irrigation of both fields began immediately thereafter. A total of 1,300 California wild rose saplings, obtained from the Mockingbird Nursery in Riverside, California, were planted at four-foot intervals (approximately 0.5 acres) in Site 1D over three days between January 9 and March 17, 2015 (Fig. 4). All plants were propagated from cuttings of wild stock collected within western Riverside County with care taken to ensure genetic diversity among plants. Site 1D was irrigated on a weekly basis after the first planting. No efforts were made to control weeds. For reasons described in the Results section, the planting of stinging nettle was postponed until Year Two.

Figure 3. One of five concrete flashboard water control boxes installed at Site 1.

Despite the effort to level Sites 1A and 1B, the channel and furrow system did not function as intended. One difficulty was moving water through the entire length of field and the time that it took to water the entire site. In general, Site 1A received less water than 1B. Some portions of both fields received adequate amounts of water whereas others received either too much or too little, and due to a strong slope in the field, water tended to collect at the northeast corner of Sites 1A and 1B.

The enhancement of Site 2 was postponed until 2015 because it took longer to prepare Site 1 than anticipated. At this time, the method of irrigation was also reconsidered. The initial plan was to extend a new pipeline from the Bridge Street Pond valve to Site 2, but instead an existing pipeline at the northern end of the Site 2 field was used. This pipeline had five turnout valves to which a series of fire hoses was connected to distribute water across the field.

Figure 4. Planting California wild rose on March 16, 2015.

Year Two

A second 8-inch metered water line was installed by the EMWD on April 16, 2015 about midway along the west side of Site 1B to help distribute water more evenly across Sites 1A and 1B. At the same time, the feasibility of laser-leveling the entire field to reduce the strong slope, facilitate a uniform flow of water across the field, and significantly reduce water consumption, was researched. Unfortunately, the costs of this work could not be covered by the grant. Instead, the level of the field was improved through land-planing, and a new plan was devised to irrigate with agricultural sprinkler lines (Fig. 5) rented from Walter Hall, a local contractor. This method required the installation of a 4-inch main line along the western side of the field which was connected to the second metered valve. Sprinkler lines were extended perpendicular to the main line across the fields. There were not sufficient funds left in the grant to rent enough sprinkler lines to cover an entire field; however, this was not a problem because the water lines could be disconnected and reconnected to different sections of the main line to irrigate the fields in sections on a rotational basis. Sprinklers are perhaps the most cost-efficient method of irrigation for this project because they do not require laser leveling and will substantially reduce water usage, labor, and maintenance costs in the future.

Site 1A was replanted with triticale and 1B with alfalfa during the second week of January 2016**.** Even in those places where triticale had grown well in Year One, it was apparent that the density was insufficient for tricolored blackbird nest construction. On the advice of a local grower, triticale seed density was increased to 120 pounds per acre, the density typically planted by dairy farmers in the San Jacinto Valley. Alfalfa seed density was decreased to 20 pounds per acre. Both crops were planted with a seed drill.

Figure 5. Alfalfa field being irrigated by sprinklers on March 23, 2016.

Weed infestation in Site 1D was extensive in Year One and the site became overgrown with cattails and large, deeply rooted non-native species that were difficult to control. For this reason, the field was cleared and replanted in Year Two. Prior to planting, Site 1D was laser-leveled by a local contractor to achieve a more complete and even distribution of water across the field, reduce water consumption, and inhibit the growth of cattails. A total of 3,600 California wild rose plants purchased from the Mockingbird Nursery were planted, consisting of 2,500 of sapling size approximately 6–8 inches in height with multiple side branches in 1-gallon

Figure 6. Student volunteers from Moreno Valley College and their professor, Dr. Joanna Werner-Fraczek.

Figure 7. Student volunteers from San Jacinto Valley College and their professor, Elliot Handrus.

containers, and 900 seedlings in 2.5-inch pots. All planting was done over 4 days between February 26 and March 18, 2016, with the assistance of student volunteers and their professors from Moreno Valley College (Fig. 6) and San Jacinto Valley College (Fig. 7). Plants were spaced four feet apart and individually marked with a pink pin flag (Fig. 8). Irrigation began immediately at weekly intervals. An herbicide treatment plan was developed for the site that included the use of glyphosate (Roundup ProMax) by a licensed applicator as needed to suppress weed growth until the shrubs were large enough to inhibit weeds through shading.

Figure 8. Pink pin flags mark the location of planted California wild rose.

A total of 2.5 acres of stinging nettle was planted at Site 1C on March 17, 2016. Seeds were prepared in advance with cold, moist stratification. Seeds were then mixed with moistened vermiculite at a ratio of 1:6 seeds to vermiculite, sealed the mixture in airtight plastic bags, and stored at 41 °F in a walk-in cold seed storage facility for six weeks. On the day of planting, the seed and vermiculite mixture was combined with dry wheat bran at a 1:1 ratio, the mixture was broadcast over the ground, and the site was irrigated. The soil was scored with a harrow prior to planting. After planting, a light roller was used to gently press seeds into the soil.

Finally, 170 willow baccharis (*Baccharis salicina*) saplings were planted at 5-foot intervals on the levees between Sites 1C and 1D on March 23, 2016 (Fig. 9). Willow baccharis is a native tree species that reaches a height of 12 feet and occurs in areas with moist soil around Bridge Street Pond and elsewhere on the Wildlife Area. The purpose of these plantings was to provide perches for tricolored blackbirds and erosion control for the levees.

The management of Site 2 is planned to begin the first week in April 2016. Rainfall has been sufficient over the winter and early spring to stimulate plant growth and prevent early desiccation. Vegetation will be mowed to maintain a height of 8 inches or less for use by foraging tricolored blackbirds (Kyle 2011) during the current breeding season.

Figure 9. Drilling holes with a gas-powered auger to plant willow baccharis on a levee at Site 1.

Monitoring

Tricolored Blackbirds

Surveys for breeding colonies of tricolored blackbirds were conducted in 2014 during the period of the statewide triennial tricolored blackbird survey April 20–22. Beginning in 2015, weekly surveys started on March 1 and continued until the end of the breeding season. Colony sites were visited in the early morning (0600–0900 h) and evening (1700–1900 h) during the early stages of nesting, settlement, and nest construction, when most birds were present, and during the early morning (0600–0900 h) during the provisioning stage of nesting since this is the time when foraging activity is greatest (Beedy and Hamilton 1999). A minimum of 15 minutes was spent estimating colony size on all visits. The scanning block technique was used, whereby an observer identifies the visual space occupied by a known number of individuals and multiplies that by the amount of space occupied by the whole group. This technique can be used to estimate both the size of foraging flocks and the density of birds at the colony site. The density of birds within the nesting substrate was estimated by counting the number of birds returning to nests within a specific field of view for a period of 5–10 minutes. The variation in density was accounted for by subdividing the area occupied into sections of different densities, estimating the number of nests within the sections, and summing the subtotals. Exact counts are virtually impossible to obtain even for small colonies so the abundance was estimated to the closest tens, hundreds, or thousands of birds.

The location of each colony site was documented, as well as its proximity to fresh water, nearest source of stored grains, primary and secondary nesting substrates, and the spatial dimensions of the area occupied. With each visit, the behavioral activity was recorded and a minimum, maximum, and best estimate of birds present by age class and sex was also recorded. The temporal stage of nesting based on behavior and activity level of the adult birds (i.e., whether they were singing or quiet, or carrying nest material or food) and whether fledglings were detected, was also recorded. The patterns of directional movement were also recorded, as well as destination of flights when these could be determined, and foraging activity on and away from the colony site. The number of fledglings was estimated (i.e., when birds left the nest and perched at the top of their nesting substrate) and juveniles (i.e., when creshes formed or when juveniles joined flocks of foraging adults). Reproductive success was quantified as the ratio of juvenile to adult female birds.

Land Cover and Vegetation

Land cover and vegetation community composition was monitored at Site 2, with surveys conducted on March 5, 2014; April 22, 2014; March 25, 2015; and March 11, 2016. The site was sampled using the point intercept method on 22 east-west oriented transects spaced every 100 feet from the southern to the northern boundary of the site. Data were collected at 65-foot intervals along transects by dropping a 0.25-inch tent pole at a random point on the ground and recording the identity, number of individuals, and maximum height of plants that made contact with the pole. All shrubs were identified to species but grasses were compiled into groups of native and non-native species. All forbs were combined into one group in 2014 surveys, but individuals were identified to species beginning in 2015.

Invertebrate Communities

Invertebrate species composition and relative abundance were assessed at Site 2 on April 20, 2014 and April 12, 2015, and at Site 1B on March 28 and April 28, 2015. Surveys were not conducted at Site 1B in the spring of 2014 due to a lack of vegetation at that time. Invertebrates were tallied by species or the lowest taxonomic group possible at twenty 10-foot-radius plots placed at random across each survey site. All vegetation within 1 m^2 at the center of each plot was removed by clipping vegetation at ground level. The clipped vegetation was shaken vigorously into a large cloth butterfly net to dislodge organisms and the contents of the net and all invertebrates observed on the ground in the clipped area were tallied. Sweep samples of invertebrates on the standing vegetation at 10 random points within the plot were also collected. Each sample consisted of three sweeps in quick succession with each sweep beginning close to ground level and swinging upward to make as much contact with the vertical extent of the vegetation as possible. Digital photos of all unidentified species were taken for later identification.

Information on prey selection was not obtained from DNA analysis because our partner (Felipe Galicia) was unable to conduct this study over the time covered by the grant. Instead, the identity of organisms carried by adult birds returning to nests to feed their young as a part of regular monitoring visits was attempted. Although neither method is quantitative or indicative of prey preference, both can reveal which prey species are utilized.

David Goodward (M.S., Entomology, University of California, Riverside) surveyed for invertebrates at the Spring-Summer Wetlands on April 12, 2015. Forty sweep net samples were collected in the wet meadow area at the south side of the cattail marsh, 40 over a sod field just south of the wetlands, and 40 in the dry upland field on the west side of the wetlands across Davis Road.

Burrowing Owls and other Sensitive Bird Species

Surveys for all bird species within the vicinity of Sites 1 and 2 were conducted on March 22, 2015; May 5, 2015; and March 18, 2016. All surveys started at 0700 h and finished by 1030 h on days when visibility did not interfere with detectability. Total counts of all bird species detected were recorded by age and sex during 10-min observation periods at each of 28 point stations spaced at intervals of approximately 0.21 miles along unpaved roadways within 1 mile of the center point of Site 1A.

Agricultural crops, alfalfa in particular, and irrigated grasslands can provide a significant source of food for burrowing owls (Manning 2009). Thus, burrowing owls and potential owl burrows were searched for along roadway levees at each of the 28 count stations and in-transit between them. Surveys for burrowing owls were also conducted within Site 2 along each of the 22 transects surveyed for vegetation. Surveys consisted of walking each transect and recording the number and type of predator species and their sign, number and type of animal burrows that were large enough to be used by burrowing owls, and number of burrowing owls observed. Data collected at burrows that exhibited evidence of occupation either currently or in the recent past (whitewash, owl pellets, prey remains) included number and age of owls observed, owl sign (pellets, feathers, whitewash), nesting stage, type of burrow use (nesting or roosting), condition, and predator species and their sign.

RESULTS

Habitat Enhancement

Year One

Approximately 10 of the 30 acres of triticale planted grew to maturity, all of it in the eastern side of the field where soils remained moist through the growing season. The remainder of the field became overgrown primarily with the non-native rocket mustard, although patches of Coulter’s goldfields up to 20 feet in diameter also grew in some areas. Alfalfa grew successfully only in areas where the soil remained moist and where it was not outcompeted by weeds, which was less than 10% of the field. Water tended to accumulate in the northeast corner of both fields where it created large shallow pools that attracted mallards (*Anas platyrhynchos*), American avocets (*Recurvirostra americana*), and other shorebirds.

California wild rose grew well with some individual plants reaching 2 feet tall by early June. However, the site also became densely overgrown with weeds by this time. Dominant species included *Amaranthus palmeri, Ambrosia acanthocarpa, Ammanium* spp., *Bassia hyssifolia, Cyperus eragrostis, Erigeron sumatrensis, Helianthus* spp., *Malvella leprosa, Polygonum lapathifolium, Phalaris* spp., *Salsola tragus, Rumex fugius*, and *Stephanomeria exigua*. By August, Russian thistle (*Salsola tragus*) and wild sunflower (*Helianthus* spp.) were the two most abundant species and covered most of the field.

The establishment of stinging nettle in Site 1C was intended to replace similar habitat that was used by tricolored blackbirds in the past. Sites 1C and 1D were prepared in November and December by disking to remove established weeds, building berms, and releasing water to assess patterns of movement across the field. Unexpectedly during this time, water collected in a large pond in Site 1C due to an eastward slope of the land. By early February, a dense stand of curly dock (*Rumex crispus*) had become established. Curly dock is a naturalized, non-native annual plant that grows rapidly in water-saturated soils at various locations on the Wildlife Area. Plants produce copious amounts of seeds attractive to blackbirds and other bird species. Before the site could be drained and prepared for planting, approximately 200 tricolored blackbirds, an equal number of red-winged blackbirds, and about 10 yellow-headed blackbirds began to roost there. All species continued to use the site for feeding, drinking, and bathing throughout the breeding season, and about 100 red-winged blackbirds nested there. For this reason, the decision was made to leave the curly dock in place, maintain water depths at about 12 inches, and postpone planting of the nettles.

Year Two

Triticale germinated well throughout the field and reached seedling stage (Fig. 10) by February 20. By April 20, plants were 2.5-3.0 feet tall and growing at a density sufficient for nesting over approximately 20 acres on the eastern side of the field (Fig. 11). However, the remaining 10 acres, mostly on the western side of the field had become overgrown and outcompeted by weeds, primarily rocket mustard (*Sisymbrium irio*) and secondarily, globe chamomile (*Oncosiphon piluliferum*), also known as false chamomile and stinknet (Fig. 12). Coulter’s goldfields were absent and chamomile covered the areas where it had grown the previous year. Globe chamomile is a highly invasive species native to South Africa and was discovered in Riverside County in 1981 and is rapidly becoming a dominant member of lowland vegetation communities in the San Jacinto Valley.

Alfalfa was about 3 inches tall on March 20 and well distributed throughout the field, although mixed with rocket mustard at about 50 percent cover (Fig. 13). By April 20, the alfalfa was 8–10 inches tall and much of the mustard had died.

On April 20, most of the California wild rose plants had new growth. About 10% of the shrubs planted, primarily those from the smaller containers, died but will be replaced at a later date. The field is watered once a week and the first herbicide treatment is scheduled for May 23. Stinging nettle has not yet emerged. Nettle seeds require 4–6 weeks of warm stratification following cold stratification. Because seeds were planted on March 17, growth is not anticipated until later April-early May.

Figure 10. Triticale seedlings at Site 1 on February 20, 2016.

Figure 11. Eastern side of triticale field with tricolored blackbirds on April 20, 2016.

Figure 12. Western side of triticale field overgrown with rocket mustard on March 20, 2016.

Figure 13. Close-up view of alfalfa and rocket mustard at Site 1 on March 23, 2016.

Figure 14. Extended area view of alfalfa at Site 1 on March 23, 2016.

Occupancy and Habitat Use by Tricolored Blackbirds

2014 Breeding Season

In the spring of 2014, tricolored blackbirds nested in two small colonies of approximately 200 birds each on the Wildlife Area (Fig. 15). One colony was located in cattail marsh along the San Jacinto River and one in the Spring-Summer Wetlands 3 miles west of Site 1. Both colonies were in the provisioning stage of nesting when first observed. Foraging activity was concentrated almost entirely in a fallow field adjacent to the eastern extent of the Spring-Summer Wetlands. The field is part of a private dairy farm. Vegetation consisted primarily of a mosaic of triticale, most likely from the seed bank of a crop from a previous year, and large patches of cheeseweed mallow, a favored host plant of the painted lady butterfly (*Vanessa cardui*). Painted lady caterpillars were observed at high frequencies on the mallow plants in this field, and in the beaks of birds returning to feed nestlings during three separate visits to the colony sites after eggs had hatched, suggesting that this species constituted an important resource for these two colonies in this year.

Figure 15. Location of tricolored blackbird breeding colonies in 2014 (blue markers) and 2015 (red markers).

2015 Breeding Season

Tricolored blackbirds nested at four locations on the Wildlife Area in the spring of 2015: Bridge Street Pond (Fig. 16), the west side of the Spring-Summer Wetlands along Davis Road (Fig. 17), Mystic Lake (Fig. 18), and the Little Ramona Duck Club (Fig. 19). Both project sites were central to the success of these colonies as were the dairies nearby. Overall, 3,400–3,800 tricolored blackbirds nested at the Wildlife Area in this year.

<u>Bridge Street Pond</u>

Approximately 400 tricolored blackbirds were first observed at Site 1 on January 8, prior to the beginning of the breeding season and shortly after crops were planted and irrigation began. These birds roosted in the emergent vegetation of Bridge Street Pond throughout the remainder of January and February, and their numbers grew as more birds settled into the area during that time. Feeding activity was concentrated at the nearest dairy.

When surveys began on March 1, this colony consisted of approximately 2,000 birds engaged in courtship and nest building. Another 200 tricolored blackbirds, roughly an equal number of red-winged blackbirds, and about 10 yellow-headed blackbirds were also constructing nests in the dense growth of curly dock at Site 1C. All tricolored blackbirds at these two sites were considered to be part of the same colony because the two sites are adjacent to each other. All three blackbird species in the area fed heavily on the seeds of the curly dock and visited this site frequently for drinking and bathing.

Figure 16. Bridge Street Pond tricolored blackbird colony site.

This colony, however, did not remain stable and declined substantially by mid-March. The majority of birds, which were nesting in cattails, abandoned the site, perhaps because the pond was accidentally over-filled with water and nests were flooded. Site 1C was also abandoned at the same time, although red-winged blackbirds continued to nest there throughout the spring. On March 25, there remained a small colony of approximately 400 tricolored blackbirds in a stand of hardstem bulrush in the southwest corner of Bridge Street Pond. This site was also occupied by about 25 nesting red-winged blackbirds and 30 yellow-headed blackbirds. Nest building did not begin until the third week of April. Once adults began to feed young, foraging occurred over a large area that included Site 1B (alfalfa field), Site 1C, Mystic Lake, and the dairy.

Figure 17. Spring-Summer Wetlands tricolored blackbird colony site.

Figure 18. Mystic Lake tricolored blackbird colony site.

Figure 19. Little Ramona Duck Club tricolored blackbird colony site.

Spring-Summer Wetlands

Tricolored blackbirds began to appear at this site during the second week of March. By April 2, the colony had grown to approximately 1,000 birds that were engaged in courtship and nest building. Nesting substrate consisted entirely of narrowleaf cattail. Some adults were first observed provisioning young on April 8 which suggests that eggs were laid no later than March 25 and as early as March 11. Insect prey consisted largely of mayflies (Order Ephemeroptera) (Fig. 20), crane flies (Family Tipulidae) and other small flies (Fig. 21), stink bugs (Family Pentatomidae) (Fig. 22) collected from the wet meadow adjacent to the marsh (Fig. 23), and grasshoppers from the dry grass/forb field across Davis Road.

This colony also declined in number from its peak on April 2 and by April 20 there remained only about 200 adults feeding young that varied in age from nestlings to fledglings. Foraging activity at this time was limited almost entirely to grasshoppers collected from the field across Davis Road. Nesting was completed by the first week in May, although a small number of adult and juvenile birds remained at the site until the end of the month.

Figure 20. Female tricolored blackbird with mayflies.

Mystic Lake

The timing and dynamics of nesting at Mystic Lake were similar to the Spring-Summer wetlands. A colony of approximately 1,000 birds was observed in the process of courtship and nest building on April 2. Nesting substrate consisted of tall, dense, weedy vegetation composed predominantly of curly dock and wild lettuce (*Lactuca serriola*) (Fig. 24). This vegetation extended over a large part of the lake basin but the colony occupied only an area in the middle of it.

Like Bridge Street Pond and the Spring-Summer Wetlands, the Mystic Lake colony declined in size during the early part of April. By April 20, there remained only about 100 nesting birds and these were feeding young. Foraging occurred over a large area that included much of Mystic Lake, Sites 1B and 1C, and the dairy along Gilman Springs Road. This site was visited on just two occasions during the nesting season due to the difficulty of access, and a determination of fledging was not made. However, the colony remained at the site until early May, which suggests fledging occurred.

Figure 21. Male tricolored blackbird with small flies.

Figure 22. Female tricolored blackbird with green stink bugs.

Figure 23. Wet meadow and shallow pools at the Spring-Summer Wetlands. The yellow flowering plants are Coulter's goldfields (*Lasthenia glabrata coulteri*), an MSHCP covered species.

Figure 24. Curly dock and wild lettuce nesting substrate in Mystic Lake.

Little Ramona Duck Club

At the same time tricolored blackbirds appeared at Site 1 in early January, another group of approximately 300 birds settled into the emergent vegetation at the Little Ramona Duck Club pond. These birds remained through the rest of the winter and began nest building in the third week of March. By April 12, adults were provisioning young. The timing suggests that eggs were laid no later than March 29 and as early as March 15. At this time, adults were most frequently observed carrying the larvae of two types of moth, both belonging to the Family Noctuidae: the cabbage looper (*Trichoplusia ni*) (Fig. 25) gathered from Site 2 and other fields west of the pond, and another species collected from the base of cattails along the shoreline (Fig. 26). The cabbage looper larva is a slender, green caterpillar about 1–1.5 inches long. Preferred host plants include wild and cultivated members of the mustard family, Brassicaceae. Non-native species of *Brassica* and *Sisymbrium* grow in abundance on the Wildlife Area. The second species is most likely the oblong sedge borer (*Capsula oblonga*), a common herbivore of cattails and one most likely found in natural stands (Penko and Pratt 1987). Oblong sedge borers bore into the stems of cattails just below the water line and would therefore be available to tricolored blackbirds.

Figure 25. Female tricolored blackbird with cabbage looper caterpillars and possibly another species.

Figure 26. Male tricolored blackbird with large dark caterpillar, possibly an oblong sedge borer.

Unlike the other three colony sites, the Little Ramona Duck Club colony grew steadily during the early part of April to an estimated 2,250 on April 20. At this time, some birds were feeding nestlings and others were caring for fledglings, but many females were constructing nests. This colony was apparently the product of at least two settlements. Most likely, birds in the early stages of nesting had immigrated from the other colonies. Young were provisioned primarily with Noctuid larvae (probably sedge borers) collected at the colony site, and with grasshoppers collected from Site 2 and other fields nearby. Grasshoppers were a pale yellow color, about 1 inch long, and abundant, especially in the vicinity of California buckwheat (*Eriogonum fasciculatum*) and other shrubs.

During the first week of May, birds from this colony began to forage frequently at Site 1 and the Mystic Lake area. Flocks of 800–1,000 birds visited the shallow pools that had formed in Sites 1A and 1B for drinking and bathing. Foraging activity appeared to concentrate at Site 1A, mostly where triticale had grown successfully, and 1C. Upon investigation, a large number of grasshoppers were observed, green and 1–2 inches long, in the vicinity of the triticale. Site 1C was used heavily for feeding, foraging, drinking, and bathing by birds from the Little Ramona and Bridge Street Pond colonies. Use of this area continued through the end of May as juveniles joined the flocks of adult birds. Adults were no longer provisioning young by May 28. Adults and juveniles remained at the nest site until the second week of June.

Juvenile Recruitment

On May 28, 3,000 adult birds were in the Little Ramona colony and roughly an equal number of juveniles. Based on an average ratio of one male to two females per territory, there were approximately 2,000 occupied nests at this site with an average reproductive rate of 1.5 young per nest in this colony.

Estimating the reproductive success of the Bridge Street Pond colony was difficult because many adults and juveniles from the Little Ramona colony (and possibly the other colonies) had started to roost at Bridge Street Pond at the same time that young from this colony were becoming independent. The 3,000 figure also does not account for reproduction from Mystic Lake or the Spring-Summer Wetlands colonies and is therefore likely an underestimate of the true magnitude of juvenile recruitment to the San Jacinto Valley population in this year.

2016 Breeding Season

Flocks of tricolored blackbirds were first observed at the Wildlife Area in 2016 on March 1. Between 500 and 600 birds were roosting once again at Bridge Street Pond, and about 100 birds at the Little Ramona Duck Club pond. Water levels in both ponds had receded below the margin of the emergent vegetation. Additional water was pumped into Bridge Street Pond since then and new growth of cattails has occurred at the site. As of March 18, there were approximately 2,000 tricolored blackbirds loafing and roosting at this site, and making forays once again to the nearest dairy and the Mystic Lake basin. Nesting substrate at the Little Ramona Duck Club pond will probably not be suitable for nesting this year. The owners of the pond intend to let it dry out for maintenance which will entail some dredging to maintain open water, and renewal of the cattails by cutting.

Land Cover and Vegetation

Between 18 and 59 percent of the Site 2 field was bare ground in March of 2014, 2015, and 2016 (Table 1). The vegetation community was low in diversity and dominated by rocket mustard in all three years (represented by the category All Forbs in 2014). Torrey seepweed (*Sueda nigra*) comprised 27 and 23 percent cover in 2015 and 2016, respectively. Silverscale saltweed (*Atriplex argentea*) increased from 8 percent in 2015 to 25 percent in 2016. Forbs observed at relatively low frequencies in all years included smotherweed (*Bassia hyssopifolia*), globe chamomile, and Coulter's goldfields. Grasses comprised less than 6% of vegetative cover in each year. Shrubs were present at the site but at very low densities and were not detected along transects.

Table 1. Results of vegetation surveys conducted at Site 2 using the point intercept method. Columns include total points and percent of total points present, mean density, and mean height of each species or plant functional group. Density is an index representing the mean number of plants present at a sampling point. The inclusive group "All Forbs" was discontinued in 2015 in favor of identifying forbs and shrubs to species. NA = Not Applicable.

March 5, 2014

Type	Total Points	Percent of Total	Density	Mean Height (inches)
Bare Ground	215	59	NA	NA
All Forbs	142	39	1.9	0.1
Non-native grasses	6	2	3.1	8.3
Native grasses	1	<1	3	1

April 22, 2014

Type	Total Points	Percent of Total	Density	Mean Height (inches)
All Forbs	195	54	1.5	2.1
Bare Ground	156	46	NA	NA
Non-native grasses	12	3	2.6	1.3
Native grasses	1	<1	3	1

March 25, 2015

Type	Total Points	Percent of Total	Density	Mean Height (inches)
Rocket mustard	249	68	1.5	10.3
Bare Ground	60	16	NA	NA
Torrey seepweed	27	7	1	15.4
Non-native grasses	18	5	3.1	8.3
Smotherweed	8	2	1.1	9.8
Silverscale saltweed	4	1	1	11.5
Globe mallow	4	1	1.8	7.3
Coulter's goldfields	3	1	1	2.6
Native grasses	1	<1	3	1

March 11, 2016

Type	Total Points	Percent of Total	Density	Mean Height (inches)
Bare Ground	200	57	NA	NA
Rocket mustard	89	25	1.7	2.0
Silverscale saltweed	25	5	1.24	1
Torrey seepweed	23	7	1	17.1
Smotherweed	7	2	1.2	1
Non-native grasses	3	1	1.33	2.2
Native grasses	1	<1	3	1.0

Invertebrate Communities

Surveys for invertebrates were conducted at Sites 1B (the alfalfa field), 1C, and 1D on March 28 and April 28, 2015. Results for 1B and 1D were combined due to similarity of vegetation composition (Table 2). The most abundant species over both survey periods was a small Mirid bug (Family Miridae) about 0.2 inches long (Fig. 27), accounting for 44% of captures in the March survey and 62% in April. The second most abundant taxa included mosquitos, gnats, and flies (Order Diptera) as a group. Species with counts of ≥20 individuals included aphids (Family Aphididae), lady bugs (Family Coccinellidae), cabbage looper caterpillars, harlequin cabbage bug (*Murgantia histrionica*), green stink bug, green dock beetle (*Gastrophysa cyanea*), cabbage white butterfly caterpillars (*Pieris rapae*), spiders, and damsel bugs (Family Nabidae). Of these groups, it is unlikely that aphids and most Dipterans would be taken by tricolored blackbirds due to their small size or difficulty of capture. The abundance of Mirid bugs declined by 57% between March and April samples while the abundance of the harlequin cabbage bug and green stink bug increased 91% and 34%, respectively.

Few organisms were observed or captured in Site 1C and of these the most abundant were gnats and lady bugs. However, numerous large holes were observed in the leaves of most curly dock plants (Fig. 28) but invertebrates were not found on the surface of the plants that could have caused such damage. Insects that feed on the leaves of *Rumex* species include Mirid bugs that have sucking mouthparts; sawfly larvae that chew leaves from the margins; the larvae of some beetles, most notably grape colapsis (*Colaspis brunnea*), which were not found in sweep samples; other species of beetle that can be excluded as potential suspects because they do not leave large holes in leaves; and Lepidopteran larvae. By process of elimination, the most likely culprit was a Lepidopteran, in particular a Noctuid larva, based on the invertebrate species observed in surveys and a careful review of the information in HOSTS (an online host plant database of the London Natural History Museum, www.nhm.ac.uk) that cross-references Lepidopteran species and their host plants. Of the species that specialize on species of the *Rumex* genus or on *Rumex crispus* in particular, only Noctuids are associated with the type of damage to plants that were observed. The species is likely one that dwells in the soil by day and emerges to feed at night, since no caterpillars were observed on the leaves. A good candidate is the cabbage moth (*Mamestra brassicae*) larva, a non-native significant pest of cabbage (Family Brassicaceae) and other agricultural crops.

Table 2. Results of invertebrate surveys at Site 1. Columns include scientific and common names of taxa observed at sampling points, and total numbers and percentages of the total of individuals observed per taxon.

March 28, 2015

Scientific Name	Common Name	Total Count	Percent of total
Family Miridae	Mirid bugs	1824	44
Order Diptera	Mosquitos, Gnats, Flies	1762	43
Trichoplusia ni	Cabbage looper	230	6
Family Coccinellidae	Lady bugs	156	4
Gastrophysa cyanea	Green dock beetle	60	2
Chinavia hilaris	Green stink bug	42	1
Order Araneae	Spiders	22	1
Suborder Symphyta	Sawfly larvae	10	<1
Vanessa cardui	Painted lady butterfly	10	<1
Zelus tetracanthus	Black striped bug	8	<1
Murgantia histrionica	Harlequin cabbage bug	6	<1
Apis mellifera	Domestic honey bee	2	<1
Suborder Oniscidea	Sow bugs	2	<1
Family Tenebrionidae	Darkling beetles	2	<1
Order Zygoptera	Damselflies	2	<1

Table 2. Continued.

April 28, 2015

Scientific Name	Common Name	Total Count	Percent of total
Family Miridae	Mirid bugs	786	62
Family Aphididae	Aphids	126	10
Murgantia histrionica	Harlequin cabbage bug	68	5
Chinavia hilaris	Green stink bug	68	5
Pieris rapae	Cabbage white butterfly	54	4
Order Diptera	Mosquitos, Gnats, Flies	44	4
Family Nabidae	Damsel bugs	24	2
Order Araneae	Spiders	18	1
Family Formicidae	Ants	18	1
Family Tenebrionidae	Darkling beetles	16	1
Family Cicadellidae	Leaf hoppers	14	1
Family Acrididae	Grasshoppers	8	1
Family Geocoridae	Big-eyed bugs	8	1
Zelus tetracanthus	Black striped bug	6	1
Order Zygoptera	Damselflies	4	<1
Apis mellifera	Domestic honey bee	2	<1
Family Coccinellidae	Lady bugs	2	<1
Order Lepidoptera	Butterflies and Moths	2	<1
Family Thomisidae	Crab spiders	2	<1

Figure 27. Mirid bugs captured in a butterfly net at Site 1.

Figure 28. Curly dock with evidence of insect herbivory.

Surveys for invertebrates were conducted at Site 2 on May 20, 2014 and April 12, 2015. Grasshoppers were the most abundant species detected in May (43% of observations), followed by darkling beetles (22%) (Table 3). Eleven other taxa made up less than 10% of observations each. The brown marmorated stink bug (*Halyomorpha halys*) was the most abundant species encountered in the April survey (81% of observations). Seventeen other taxa made up 4% or fewer of observations each. Although species diversity appears to have been higher in 2015 than 2014, this could be due to differences in the timing of surveys. The predominance of grasshoppers observed in 2014 versus 2015 may also be due to the timing of surveys in those two years as grasshoppers in this area generally emerge in May or June (Dr. Greg Ballmer, University of California, Riverside, personal communication).

Table 3. Results of invertebrate surveys at Site 2. Columns include scientific and common names of taxa observed at sampling points, and total numbers and percentages of the total of individuals observed per taxon.

May 20, 2014

Scientific Name	Common Name	Total Count	Percent of Total
Family Acrididae	Grasshoppers	88	43
Family Tenebrionidae	Darkling beetles	46	22
Pieris rapae	Cabbage white butterfly	20	10
Suborder Zygoptera	Damselflies	17	8
Suborder Oniscidea	Sow bugs	13	6
Order Araneae	Spiders	8	4
Suborder Anisoptera	Dragonflies	5	2

Table 3. Continued.

Common Name	Total Count	Percent of Total	Common Name
Family Lycaenidae	Blue butterfly	3	2
Lepisma saccharina	Silverfish	2	1
Family Coccinellidae	Lady bugs	1	1
Order Ephemeroptera	Mayflies	1	1
Order Hemiptera	True Bugs	1	1

April 12, 2015

Scientific Name	Common Name	Total Count	Percent of total
Halyomorpha halys	Brown marmorated stink bug	1338	81
Murgantia histrionica	Harlequin cabbage bug	62	4
Family Miridae	Mirid bugs	58	4
Order Araneae	Spiders	50	3
Family Cicadellidae	Leaf hoppers	36	2
Family Coccinellidae	Lady bugs	21	1
Chinavia hilaris	Green stink bug	18	1
Family Acrididae	Grasshoppers	13	1
Family Nabidae	Damsel bugs	12	1
Order Diptera	Mosquitos, Gnats, Flies	13	1
Family Reduviidae	Assassin bugs	7	<1
Family Tenebrionidae	Darkling beetles	7	<1
Order Lepidoptera	Butterflies and Moths	4	<1
Order Dermaptera	Earwigs	2	<1
Pieris rapae	Cabbage white butterfly	2	<1
Order Ephemeroptera	Mayflies	1	<1
Lepisma saccharina	Silverfish	1	<1

David Goodward did not supply counts from his surveys at the Spring-Summer Wetlands site; however, he reported that the most abundant organisms were flower, or Syrphid, flies (Family Syrphidae). Other taxa observed at lower frequencies included Tachinid flies (Family Tachinidae), bee flies (Family Bombyliidae), robber flies (Asilidae), thread-waist wasps (Family Sphecidae), assassin bugs (Reduviidae), honey bees, stink bugs, and aquatic beetles.

Burrowing Owls and Other Sensitive Bird Species

One inactive burrowing owl burrow was discovered at Site 2 during our April 23, 2014 survey. The area surrounding the burrow entrance had whitewash and owl pellets and appeared to have been occupied the previous winter. Subsequent surveys revealed no sign of owls at this site.

A total of 37 bird species were detected in our March 22, 2015 survey, including 35 on May 5, 2015, and 29 on March 18, 2016 (Table 4). The tricolored blackbird was the most numerous on all occasions. The red-winged blackbird was second in abundance in two of the three surveys, followed by the American coot (*Fulica americana*) and northern shoveler (*Anas clypeata*). Four California Species of Special Concern were observed: northern harrier (*Circus cyaneus*) and loggerhead shrike, in all three surveys; and the redhead (*Aythya americana*) and yellow-headed blackbird in two surveys. Six species that have no special status but are tracked by the California Natural Diversity Database (CNDDB) were observed: the white-face ibis (*Plegadis chihi*) and horned lark, in three and two surveys, respectively; and Cooper's hawk (*Accipiter cooperii*), great blue heron (*Ardea herodias*), and white-tailed kite (*Elanus leucurus*) in one survey. Turkey vulture (*Cathartes aura*), an MSHCP-covered species but not tracked by the CNDDB, was observed in one survey.

Table 4. Results of bird point count surveys. Columns include scientific and common names of bird species and total counts of individuals observed at 28 survey points on three sampling dates. Species are listed in alphabetical order by scientific name.

Scientific Name	Common Name	3/22/2015	5/5/2015	3/18/2016
Accipiter cooperii[4]	Cooper's hawk	1	0	0
Agelaius phoeniceus	Red-winged Blackbird	55	401	435
Agelaius tricolor[1]	Tricolored blackbird	0	1818	2304
Aix sponsa	Wood duck	0	2	0
Anas americana	American wigeon	6	0	0
Anas clypeata	Northern shoveler	165	4	50
Anas cyanoptera	Cinnamon teal	10	2	0
Anas platyrhynchos	Mallard	24	40	62
Ardea alba[5]	Great egret	7	1	6
Ardea herodias[4]	Great blue heron	0	1	0
Aythya americana[3]	Redhead	0	3	4
Bucephala albeola	Bufflehead	0	0	2
Buteo jamaicensis	Red-tailed hawk	6	5	4
Calidris alpine	Dunlin	4	0	0
Carpodacus mexicanus	House finch	10	3	0
Cathartes aura[6]	Turkey vulture	1	0	0
Charadrius vociferus	Killdeer	13	2	4
Circus cyaneus[2]	Northern harrier	15	1	11
Cistothorus palustris	Marsh wren	3	0	3
Columba livia	Rock pigeon	0	0	3
Corvus corax	Common raven	16	25	33
Elanus leucurus[4]	White-tailed kite	0	1	0
Emberizidae	Unidentified sparrow	30	3	10
Eremophila alpestris[4]	Horned lark	0	3	0
Fulica americana	American coot	184	27	19
Geothlypis trichas	Common yellowthroat	2	0	0
Himantopus himantopus	Black-necked stilt	12	6	0
Icteridae	Unidentified blackbird	0	12	13
Lanius ludovicianus[2]	Loggerhead shrike	3	11	3
Laridae	Unidentified gull	3	0	27
Larus larus[5]	California gull	1	0	0
Melospiza melodia[5]	Song sparrow	14	10	8
Melozone crissalis	California towhee	1	0	0
Mimus polyglottos	Northern mockingbird	1	3	4
Oxyura jamaicensis	Ruddy duck	37	5	5
Passerculus sandwichensis	Savannah sparrow	34	4	12
Passerina caerulea	Blue grosbeak	0	2	0
Petrochelidon pyrrhonota	Cliff swallow	0	171	0
Phasianus colchicus	Ring-necked pheasant	1	0	0
Plegadis chihi[4]	White-faced ibis	35	0	90
Podilymbus podiceps	Pied-billed grebe	1	0	0
Porzana carolina	Sora	2	1	0

Table 4. Continued.

Scientific Name	Common Name	3/22/2015	5/5/2015	3/18/2016
Quiscalus mexicanus	Great-tailed grackle	0	1	2
Recurvirostra americana	American avocet	23	11	0
Sayornis nigricans	Black phoebe	4	0	1
Spinus psaltria	Lesser goldfinch	0	50	0
Streptopelia decaocto	Eurasian collared-dove	0	1	1
Sturnella neglecta	Western meadowlark	44	31	5
Sturnus vulgaris	European starling	0	0	1
Tringa flavipes	Lesser yellowlegs	1	0	0
Tyrannus verticalis	Western kingbird	1	1	28
Xanthocephalus xanthocephalus[3]	Yellow-headed blackbird	0	1	5
Zenaida macroura	Mourning dove	2	8	4
Zonotrichia leucophrys	White-crowned sparrow	16	0	69

1: Candidate for listing, California Endangered Species Act, 2: California Species of Special Concern (SSC) and covered by the MSHCP, 3: SSC only, 4: Tracked by the California Natural Diversity Database (CNDDB) and covered by the MSHCP, 5: Tracked by the CNDDB, 6: Covered by the MSHCP only.

DISCUSSION

Many of the objectives stated above were successfully achieved within the timeframe of this project. First, the feasibility of enhancing habitat for the tricolored blackbird was demonstrated at the Wildlife Area. Among these, triticale and alfalfa were found to grow well in the non-amended alkaline soils on the Wildlife Area given sufficient irrigation. Insect production, even without the success of the alfalfa crop in the first year, was sufficient in type and abundance to support four successful colonies of tricolored blackbirds within close proximity to each other. Attractants such as grain or model decoys were unnecessary because large flocks of tricolored blackbirds began to appear at Site 1 soon after irrigation of the fields began in January 2015. The mosaic of shallow pools, lush vegetation, and the large stand of curly dock that developed with the application of irrigation water at Site 1 created an attractive environment for both winter and spring habitation. For the first time in 10 years, breeding activity within the San Jacinto Valley was confined to the Wildlife Area and a conservation easement inholding. Dairy farms were visited frequently by wintering and breeding tricolored blackbirds but no nesting occurred at these sites. Most importantly, reproductive success exceeded the average replacement rate of adult birds (60%, Meese 2013) by 1200, or 40%, which constituted a substantial net gain to the population. Many more years of strong recruitment are needed to restore the population to the levels present in the early part of the 1990s (20,000-30,000). However, results of this project suggest that such a goal may be achievable.

Nesting Substrate

Comparisons regarding preferences for upland nesting substrate types were not able to be made since the native shrubs and forbs planted will not be sufficiently developed as nesting substrate for another 2–4 years. This was anticipated at the beginning of this project and plans have been made to obtain more information as the monitoring of habitat use and nest site selection continues in the future.

Two preliminary observations have been made that warrant further investigation. First, one of the features that appear to have made the habitat at Site 1 attractive for tricolored blackbirds was the shallow pools that formed, unintentionally, in the first year. Large flocks of blackbirds frequently visited these pools to drink and bathe. These shallow pools also attracted mallards, American avocets, and other shorebirds that nested under the cover of the triticale that grew in abundance around the pools. Spring brooding habitat is rare at the Wildlife Area and one of the unanticipated benefits of this project was an exceptionally large number of young fledged by these species.

Second, curly dock appeared to be an attractive and valuable resource for tricolored, red-winged, and yellow-headed blackbirds. This non-native species favors water-logged soils, grows rapidly in the winter, and produces large panicles with thousands of seeds that ripen between April and May. The seeds appeared to constitute an important source of food for adults of all three species of blackbird at Site 1. Curly dock is also a favored host plant of the cabbage moth. The plants at Site 1C were colonized rapidly in early spring by this or another species of Noctuid moth, the larvae of which most likely provided a source of food for nestling tricolored blackbird in the Bridge Street Pond colony and possibly the Ramona Duck Club colony.

Curly dock is utilized as nesting substrate by red-winged blackbirds and in some parts of the country it even appears to be preferred over others (Smith 2003); however, such use by tricolored blackbirds was apparently undocumented prior to this study. The cause of Site 1C being abandoned by tricolored blackbirds shortly after nest building began was unclear because a colony of similar size completed a nesting cycle successfully in similar habitat a short distance away in Mystic Lake. There was possibly too much competition for space from red-winged blackbirds at Site 1C. Another possibility is that the Mystic lake site offered greater protection from predators like coyotes and raccoons because it was embedded within a large expanse of tall and dense vegetation. There is still much to learn about nest site selection by tricolored blackbirds, but results from studies like the present one under controlled and comparable field conditions can contribute a great deal to our knowledge in the future.

Foraging Habitat

Tricolored blackbirds utilized a wide variety of insect prey at the Wildlife Area during the first year of this study, corroborating results of earlier studies that suggest this species is largely an opportunistic generalist, exploiting whatever suitable prey are available to them (Crase and DeHaven 1977). Preliminary results of this study suggest prey selection may be proportional to the relative abundance of these organisms in the environment. Invertebrate species composition at the two colony sites where good observations of feeding behavior (Spring-Summer Wetlands and Little Ramona) were made reflected differences in land cover and natural community types.

The Spring-Summer Wetlands nest site was bordered on the south by lush wet meadow and shallow pools that supported sedges, other wetland plant species, and flowering plants characteristic of vernal pool communities in western Riverside County. Invertebrates large enough to be useful to tricolored blackbirds, including flower (or syrphid) flies, mayflies, crane flies, and Hemipterans were most abundant in sweep net samples and were among the organisms most frequently observed being carried by adult birds, along with grasshoppers collected from dry grasslands to the west.

By contrast, caterpillars were conspicuously absent at the Spring-Summer Wetlands but appeared to constitute important prey items for the Little Ramona colony, along with grasshoppers that emerged later in the breeding season. Foraging habitat was drier at this site and consisted primarily of forb/shrubland dominated by rocket mustard. Here, birds were observed returning to the nest site primarily with caterpillars of the cabbage looper moth in April and grasshoppers in May, a sequence that matched the timing of emergence of these organisms (Dr. Greg Ballmer, University of California, Riverside personal communication). The cabbage looper deposits eggs singly on weed hosts, especially wild mustard species. Larvae hatch in 3-5 days and feed for two weeks before pupating on the host plant or in plant debris. Total development time is 30 days, and four generations can be produced within a single year. Host plants must remain green and edible to larvae during this period if they are to provide a reliable food source for tricolored blackbirds. In the absence of sufficient spring rainfall at the Wildlife Area, rocket mustard is dry and brown by early May, as it was in 2015. Coincidentally, no caterpillars were observed at this site on the 20 May survey.

Another important prey item for the Little Ramona colony was caterpillars of another Noctuid moth, most likely the oblong sedge borer. Adults are nocturnal and produce one generation per year. The larvae start life as leaf miners but the final instar bores into the base of cattails and bulrush below the water line to feed on the stems where it pupates and over-winters (Penko and Pratt 1987). The cause of tricolored blackbirds not utilizing this species at the Spring-Summer Wetlands is unclear. A possible explanation is the difference in management of the two sites. The Little Ramona pond has held cattails undisturbed for more than two years. However, water to the Spring-Summer Wetlands is turned off in June each year and the vegetation is allowed to desiccate until irrigation begins again, usually in late January. In the fall, about 75% of the cattail stand is mowed to the ground. Birds were possibly taking caterpillars from cattails in that portion of the marsh that remained undisturbed from the previous year, if any had survived, but this would have been difficult to observe as this area was deep inside the marsh.

Inland southern California supports a high diversity of grasshopper species which can vary widely in habitat use and life histories (Dr. Douglas Yanega, University of California, Riverside, personal communication). At least two different species were detected during the late spring of 2015 at the Wildlife Area, one in the upland fields adjacent to the Spring-Summer Wetlands and Little Ramona colonies, and the other in association with triticale at Site 1. Both species were exploited heavily by foraging tricolored blackbirds that were provisioning nestlings at this time. The highest abundances were present in those microhabitats where the vegetation remained green, in shallow swales at Site 2 and other fields around it, and in stands of triticale.

What is clear from these results is that a mosaic of foraging habitats is likely important to support a single colony as different types of insects emerge and predominate at different times during the nesting cycle. The high degree of asynchrony in nesting observed in 2015 as colonies formed, increased, then decreased in size as birds shifted between them was likely due to temporal shifts in prey availability.

Timing of Reproduction

Reproductive activity began earlier than usual in 2015, as early as the first week in March at the Spring-Summer Wetlands and the Little Ramona Duck Club pond. Similar observations were made in recent years in the Central Valley (Samantha Arthur, Audubon California and Robert Meese, University of California, Davis personal communications) and for this reason, the annual and triennial statewide surveys have been moved back to the second week of April.

The high degree of asynchrony in nesting made it difficult to accurately estimate population size because many birds were incubating eggs at the same time that others were provisioning chicks. Under these circumstances, reasonably accurate estimates require observations over a period of weeks. Shorter duration surveys will tend to underestimate numbers.

Management

The control of the growth of undesired plants in agricultural crops to prevent excessive competition can be challenging. In both years of this project, triticale grew successfully in the western side of the field where the soil remained moist between watering whereas weeds became predominant and appeared to outcompete young plants in drier parts of the field. Although efforts were made to increase the uniformity of the field in both years, there remained enough of a slope that water tended to flow in this direction. Planting density appeared to be an important factor as well. The increase in seed density between years from 23 to 120 pounds per acre likely increased the density of mature plants to a level suitable for nesting blackbirds. Furthermore, plants grew taller, with greater evenness, and over a larger extent in the second year suggesting an interaction between water availability and planting density that yielded greater success in competition with weeds. Similarly, alfalfa was able to thrive in areas that received sufficient water despite an abundant cover of rocket mustard. The perennial growth of alfalfa might give it an advantage over this annual non-native in the months to come.

Another important factor in the control of weeds may be timing. Planting triticale between mid-November and mid-December may help prevent overgrowth of weeds by giving young plants a chance to become established before weeds germinate (Walter Hall, personal communication). For example, triticale was planted on 20 acres at the Four Winds Pheasant Club adjacent to Site 1 in mid-December of 2015. Few weeds developed in this field despite an absence of herbicide use. Planting earlier, perhaps late November to early December, is also necessary for triticale to be of suitable height for nesting at the beginning of the breeding season. Given that tricolored blackbirds appear to have started nesting earlier than in the past, it is advisable to consider starting triticale earlier, perhaps mid-November; however, it is not clear if earlier planting will result in earlier maturity of plants because some level of dormancy occurs over the winter months.

Given the temporal variability in insect production and the need to provide a continuous source of food for nestlings, it is important to maintain a mix of foraging habitats including wetlands and uplands in the vicinity of colony sites. Because many invertebrates overwinter in the soil or pupate on the leaves and stems of annual and perennial forbs, gentle clearing of desiccated vegetation is recommended, using methods like raking that do not have a heavy impact on the soil.

Maintenance of nesting substrates at all colony sites used by tricolored blackbirds in recent years must be ensured. Management of healthy cattail stands often requires the removal of above ground vegetation at intervals of 3–5 years. Maintenance of open water in a pond may also require periodic dredging and removal of cattails which in turn requires that the pond be drained or allowed to dry out before work can be done. Therefore, it is important that emergent vegetation be managed in such a way that at least one colony site retains a sufficient amount of suitable nesting substrate in any given year. Such coordination should involve both Wildlife Area staff and Little Ramona Duck Club property owners.

The Spring-Summer Wetlands were an important early season colony site for tricolored blackbirds in 2015. Not only did the cattails provide nesting substrate, but the wet meadow and vernal pool complex that formed next to them provided an important source of food for nestlings. In previous years, irrigation of the wetlands for the growth of cattails started at the end of January. Given the apparent earlier starting dates of tricolor breeding activity in recent years, it is advisable that irrigation be started no later than mid-January. At least 5 acres of cattails should be left standing each year. First-year cattail growth is often insufficient for nest building (Robert Meese, personal communication). Indeed, it was that part of the Spring-Summer Wetlands where cattails were left standing from the previous year that nesting occurred in both 2014 and 2015. Maintaining standing cattails will also help conserve cattail herbivores such as sedge borers that constitute an important food source for nestlings.

Given the substantial value of curly dock to tricolored blackbirds and other blackbird species, creating another sectioned field to be managed for this plant at Site 1 is recommended. Curly dock begins growth in the early winter months. The conditions that favor this species also promote the growth of cattails, although germination and rhizomatous spread begin primarily in the spring. Cattails will likely outcompete curly dock by early summer as dock plants senesce. There are a number of ways to control cattails including dredging, frequent mowing and disking, prescribed burning or mowing followed by flooding, and chemical control (Sojda and Solberg 1993). Dredging is expensive and disruptive, and burning and mowing will not control cattails unless repeated over several growth cycles. Therefore, chemical control is probably the best option in this case. Glyphosate in the products Roundup and Rodeo are effective but only if applied in late summer or early fall when cattails are flowering but before they have set seed (Solberg and Higgins 1993). Dead cattails could be removed in early winter, and the site flooded periodically with 12 inches of water to encourage the growth of curly dock.

Modifications to the Proposed Project

The original plan for this project was to plant 2 acres of native shrubs on the east side of Site 1C. However, EMWD stated that the area could not be used without additional modifications to the land to prevent irrigation water from entering Mystic Lake. The decision was then made to split the 5-acre field closest to Bridge Street Pond, in which stinging nettle was to be planted, into two 2.5-acre fields, one for nettle and one for rose. Only 1.5 acres of wild rose was planted by the end of Year Two due to the loss of plantings to weeds in Year One. However, the existing plantings could possibly spread by vegetative reproduction to cover more area, given sufficient irrigation and weed control. Although only 2.5 acres of nettle was planted by the end of year two, there is the option of extending coverage another 2.5 acres or more if plants grow successfully.

There was a plan to establish a three-foot-wide strip of stinging nettle around the triticale field as a protective barrier against terrestrial predators like coyotes and raccoons. The nettle was to be a cost-effective method of deterring ground predators for the very reason that it gives protective cover to nesting tricolored blackbirds. However, the need for staff to be able to enter the field to manage the irrigation system and the crops in the field precluded this option.

Although it was necessary to re-design the method of irrigation for the triticale and alfalfa fields, the sprinkler system substantially reduced water use over the previous year. The system also allowed sections of the alfalfa field to be irrigated on a rotational basis. Many invertebrates such as Noctuid moth larvae and some beetles and arachnids remain in the soil during the day and emerge at night. Irrigation can drive these organisms to the surface to be available to foraging tricolored blackbirds during the day. Furthermore, the ends of the sprinkler lines can be uncapped at strategic locations to create the shallow pools favored by tricolored blackbirds for drinking and bathing. Long term savings over the cost of equipment rental could be achieved through the purchase of an irrigation system by the Wildlife Area.

Future Work

More will likely be learned about the relationships between habitat conditions and behavioral responses of tricolored blackbirds through the extension of monitoring that began with this project. Specifically, there is the intention to continue monitoring vegetation composition and condition, invertebrate composition and abundance, prey selection, and patterns of occupancy and resource use by sensitive species of birds and other species.

Schedule for monitoring

Surveys for tricolored blackbirds should begin the first week of March and continue at weekly intervals if birds are found, or every two weeks until found, through the end of the breeding season. Tricolored blackbirds are also surveyed as part of the coordinated statewide survey during the second week of April. Results of these surveys are recorded on the Tricolored Blackbird Portal (http://tricolor.ice.ucdavis.edu/). Surveys of the vegetation, invertebrate community, burrowing owls and other sensitive bird species should be conducted annually as indicated in Table 5. If possible, invertebrate surveys should be conducted in the immediate vicinity of any active tricolored blackbird colony and anywhere else birds are observed foraging. These surveys should also occur throughout the breeding season because different taxa emerge and become predominant at different times.

Table 5. Recommended schedule for biological monitoring surveys of tricolored blackbird habitat enhancement project sites on the San Jacinto Wildlife Area.

Date	Vegetation	Invertebrates	Bird Species Community
March 1-7	X	X	
March 8-14			X
April 1-7	X	X	
April 8-14			X
May 1-7	X	X	

Cost savings and self-sufficiency

The long-term aim is to achieve financial self-sufficiency for site maintenance through the use of agricultural leases or other means. There is strong interest by dairy farmers and other local growers in the San Jacinto Valley to participate in these types of agreements, in which the costs for production, including irrigation water, are covered by the private parties. The shrubs and forbs planted as perennial upland nesting substrate will require less water as they become well-established. Depending on the results of future monitoring, alfalfa may be alternated or transitioned to other non-invasive pasture forbs or grasses to reduce water consumption or to prevent destructive build-up of harmful nematodes and other pests. Finally, crops could be discontinued if management of project natural areas produces suitable insect prey in sufficient quantity.

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REFERENCES

Baird S. F., Brewer T. M., and Ridgeway R. 1874. A History of North American Birds. Landbirds, volume II. Little, Brown. Boston, MA.

Beedy E. C., Hamilton W. J., III. 1999. Tricolored Blackbird (*Agelaius tricolor*). In Poole A., Gill F., editors. The Birds of North America No. 611. The Birds of North America, Inc. Philadelphia, PA. Available online: http://bna.birds.cornell.edu/bna/species/423.

Beedy, E. C. 2008. Tricolored Blackbirds (*Agelaius tricolor*). In W. D. Shuford and T. Gardali, editors. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Berg E. C., Pollinger J. P., and Smith T. B. 2010. Population structure of the Tricolored Blackbird (*Agelaius tricolor*) in California: Are northern and southern populations genetically distinct? California Department of Fish and Game, Nongame Wildlife Program Rpt. 2010-05 and Audubon California, Sacramento, CA.

Biological Monitoring Program. 2011. Western Riverside County MSHCP Biological Monitoring Program. Tricolored Blackbird (*Agelaius tricolor*) Survey Report, 2010 with Overview of Recent History and Current Status in Southern California. Report. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available at http://wrc-rca.org/about-rca/monitoring/monitoring-surveys/.

Biological Monitoring Program. 2013. Western Riverside County MSHCP Biological Monitoring Program. Tricolored Blackbird (*Agelaius tricolor*) Survey Report, 2012. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available at http://wrc-rca.org/about-rca/monitoring/monitoring-surveys/.

Biological Monitoring Program. 2014. Western Riverside County MSHCP Biological Monitoring Program. Tricolored Blackbird (*Agelaius tricolor*) Survey Report, 2013. Report prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available at http://wrc-rca.org/about-rca/monitoring/monitoring-surveys/.

Birdlife International. 2012. *Agelaius tricolor*. The IUCN Red List of Threatened Species 2012: e.T22724196A39900728. Available at http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T22724196A39900728.en.

Crase F. T., and DeHaven R. W. 1977. Food of nestling Tricolored Blackbirds. Condor 79:265–269.

Cook L. F., and Toft C.A. 2005. Dynamics of extinction: Population decline in the colonially nesting Tricolored Blackbird (*Agelaius tricolor*). Bird Conservation International 15:73–88.

Cooper, D. S. 2014. San Jacinto Valley Important Bird Area: Conservation Action and Planning Steps. Prepared for Audubon California, Morro Bay, CA.

Collier, G. 1968. Annual cycle and behavioral relationships in the Red-winged and Tricolored Blackbirds of southern California. PhD dissertation, University of California, Los Angeles.

DeHaven, R. W., Crase, F. T., and Woronecki, P. P. 1975. Breeding status of the Tricolored blackbird, 1969-1972. California Department of Fish and Game 61:161-180.

DeHaven, R. W. and Neff, J. A. 1973. Recoveries and returns of tricolored blackbirds 1941-1964. Western Bird Bander 48:10-11.

DeSante, D. F. and Geupel, G. R. 1987. Landbird productivity in central coastal California: The relationship to annual rainfall and a reproductive failure in 1986. Condor 89:636-653.

Dudek & Associates. 2003. Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). Final MSHCP, Volumes I and II. Prepared for County of Riverside Transportation and Lands Management Agency. Riverside, CA.

Grant, P. R., Grant, B. R., Keller, L. F. and Petren, K. 2000. Effects of El Niño events on Darwin’s finch productivity. Ecology 81:2422-2457.

Kyle, K. 2011. Tricolored Blackbird Habitat on California Department of Fish and Game Properties: An Assessment of Existing and Potential Habitat and Recommendations for Habitat Improvement and Maintenance. Nongame Wildlife Program report 2011-07. State of California, Department of Fish and Game, Sacramento, California.

Lack, D. 1954. The Natural Regulation of Animal Numbers. Oxford University Press. Oxford, U.K.

Manning, J. A. 2009. Burrowing Owl Population Size in the Imperial Valley, California: Survey and Sampling Methodologies for Estimation. Final Report to Imperial Irrigation District, Imperial, California.

Martin, T. E. 1993. Nest predation among vegetation layers and habitat types: Revising the dogmas. American Naturalist 141:897-913.

Meese, R. J. 2011. Trapping and Banding of Tricolored Blackbirds (*Agelaius tricolor*) in 2011. University of California, Davis, CA. Available at http://tricolor.ice.ucdavis.edu/reports.

Meese, R. J. 2012. Cattle egret predation causing reproductive failures of tricolored blackbirds. California Department of Fish and Game 98:47-50.

Meese, R. J. 2013. Chronic Low Reproductive Success of the Colonial Tricolored Blackbird from 2006 to 2011. Western Birds 44:98-113.

Meese, R. J. 2014. Results of the Tricolored Blackbird Statewide Survey. University of California, Davis, CA. Available at http://tricolor.ice.ucdavis.edu/reports.

Mineau, P., and Palme, C. 2013. The Impacts of the Nation's Most Widely used Pesticides on Birds. American Bird Conservancy.

Morrison, S. A. and Bolger, D. T. 2002. Variation in a sparrow's reproductive success with rainfall: Food and predator-mediated processes. Oecologia 133:315-324.

Neff, J. A. 1937. Nesting distribution of the Tricolored Red-wing. Condor 39: 61-81.

Neff, J. A. 1942. Migration of the tricolored red-wing in central California. Condor 44:45-53.

Nero, R. 1984. Redwings. Smithsonian. Washington D.C.

Paulek, T., and Nash, S. 2007. Nest Colony Monitoring of Tricolored Blackbirds in Southern California. Unpublished report available at http://tricolor.ice.ucdavis.edu/.

Penko, J. M., and Pratt, D. C. 1987. Insect herbivory in Minnesota Typha stands. Journal of Freshwater Ecology 4:235-244.

Putnam, D., and Kaffka, S. 1995. The importance of alfalfa to cropping systems and environmental goals. Proceedings, 25th California Alfalfa Symposium, 7-8 December, Modesto, CA.

Smith, L. M. 2003. Playas of the Great Plains. University of Texas Press. Austin, Texas.

Tricolored Blackbird Working Group. 2007. Conservation Plan for the Tricolored Blackbird (*Agelaius tricolor*). Susan Kester (ed.). Sustainable Conservation. San Francisco, California.

Solberg, K. L., and Higgins, K. F. 1993. Effects of Glyphosate herbicide on cattails, invertebrates, and waterfowl in South Dakota wetlands. Wildlife Society Bulletin 21:299-307.

Smallwood, K. S., and Geng, S. 1993. Alfalfa as wildlife habitat. Proceedings, 23rd California Alfalfa Symposium, December 6–7, Visalia, California.