

## Breeding Tricolored Blackbirds in the Central Valley, California: A Quarter-Century Perspective

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**Abstract:** The Tricolored Blackbird (*Agelaius tricolor*) is an endemic, colonial-nesting passerine occurring largely (>99%) in California, but extending in small numbers into western coastal Baja California, Nevada, Oregon, and Washington. In California, the species' range includes the Central Valley, surrounding foothills, coastal areas, and certain inland areas of southern California. During the 1970s, while part of a research team studying blackbird depredations to ripening rice, I studied and published descriptions of the Tricolor's morphology, movements, feeding habits, and breeding population status. We concluded that the breeding population in the Central Valley had declined dramatically since the time of a previous study in the 1930s. Then from the 1970s until now I had no further involvement with Tricolors. However, other workers have conducted studies, starting in the early 1990s, which have documented continuing breeding population declines. For example, the estimated total breeding population, which historically numbered many millions, declined from an estimated 350,000+ in 1994 to an estimated 105,000 in 1999. To help corroborate and assess the significance of these recent observations and assist in developing effective management strategies which may preclude the need for listing, I briefly resurveyed Central Valley breeding populations of Tricolors during the spring of 2000. My 1,053-mile, 44-hour survey of portions of 13 counties found only seven colonies totaling an estimated 21,275 breeding and 25 non-breeding birds. Evidence of habitat loss, from urban expansion and agricultural conversions from such high-value (for Tricolors) uses as livestock forage production, to low- or no-value uses such as vineyards and orchards, was widespread. These present observations support a conclusion of another large population decline between the 1970s and today, and are consistent with key findings of the other recent workers. Much of the remaining breeding population is now associated with large dairy operations in the San Joaquin Valley. Nesting often occurs in grain fields these dairies grow for dairy cow silage; this appears to be a relatively new phenomenon which I did not observe in the 1970s. Such dairies offer either a significant threat (from continued reproductive failures associated with fields being harvested while birds are nesting) or an opportunity for long-term preservation of the species, if the threat can be ameliorated. However, even if this and other problems are resolved through concerted management efforts, this species will likely never be restored to any of its former population levels. Our best hope is to stabilize and maintain the population at some lower level. Specific management recommendations and research priorities, necessary for initiating a stabilization process are presented in detail.

## INTRODUCTION AND BACKGROUND

The Tricolored Blackbird (*Agelaius tricolor*) is an endemic, colony-nesting passerine occurring largely (>99%) in California, but extending in small numbers into western coastal Baja California, Nevada, Oregon, and Washington. In California, the species' range includes the Central Valley, surrounding foothills, coastal areas, and certain inland areas of southern California (Beedy and Hamilton 1999).

My involvement with this bird dates to about 1969 when I joined a research team from the U. S. Fish and Wildlife Service's (Service) Division of Wildlife Research investigating the problem of blackbird damage to ripening rice in the Sacramento Valley. This work included ecological studies of the various blackbird species involved in the depredations problem. Findings from our work with Tricolored Blackbirds (Tricolors), one of the involved species, were published in papers describing the species' morphology (DeHaven 1975), movements (DeHaven and Neff 1973; DeHaven et al. 1975a), feeding habits (Crane and DeHaven 1977, 1978; Skorupa et al. 1980), and breeding population status (DeHaven et al. 1975b).

Our breeding status results (DeHaven et al. 1975b) indicated that the Tricolor's general range and major breeding areas had remained largely unchanged for over 35 years since a prior intensive study by Neff (1937) during the 1930s. However, we concluded (DeHaven et al. 1975b) that population size, at least within the Central Valley, had dramatically declined by 50% or more during the 1970s compared to the 1930s.

The Service's research on the rice depredations problem was terminated in the late 1970s. Consequently, from about 1975 until 2000 I had no further involvement with Tricolors, either professionally or personally as a bird-watcher. Also, from about the mid 1970s until the early 1990s there were, to my knowledge, no other intensive studies of Tricolors.

However, beginning about 1992, another intensive Tricolor study era was initiated which continues today. The principle workers in this recent effort are William J. Hamilton III (Emeritus Professor, University of California at Davis=UCD); Liz Cook (former UCD graduate student, now with California Department of Water Resources); and E. C. (Ted) Beedy of Jones and Stokes, Inc. (environmental consulting firm), Sacramento, California. Collectively, studies by this group have resulted in a number of reports, publications, and one thesis (Cook; Master of Science) on Tricolors. Much of the work was recently coalesced into a "Birds of North America" monograph by Beedy and Hamilton (1999).

A key finding of the 1990s studies is that the Tricolor population appears to be continuing in decline (*in* Beedy and Hamilton 1999; Hamilton et al. 1999). Beedy and Hamilton (1999) list the principal causative factors of decline as continuing alteration and loss of nesting and foraging habitat, direct destruction of nesting colonies by agricultural operations (especially harvesting of grain silage fields near dairies while birds are nesting; *see* later discussion), predation, and perhaps other factors such as exposure to toxics.

Based on its status, the Tricolor is presently considered a "Species of Concern" by the Service and a "Bird Species of Special Concern" by the California Department of Fish and Game (DFG). It was also previously a Federal candidate for listing as either Threatened or Endangered by the Service [59 Federal Register (219):58990].

To corroborate the Tricolor's indicated status and trends, and assist in developing an effective management strategy which may preclude the need for its eventual listing, additional population and biological observations and data are vitally needed. Utilizing my past experience with this species, I attempted to address this need by conducting a brief breeding population survey of Tricolors during the 2000 nesting season. The primary objective was to compare and contrast my current observations of this species (and its habitat) to my observations made over 25 years ago. I report here my survey results, conclusions, and recommendations. I thank William J. Hamilton III and Ted Beedy for helpful comments on an earlier draft of this report.

## METHODS

The survey was conducted during April and May 2000 within the Central Valley. As during my earlier (1970s) studies, I searched for breeding Tricolors while traversing roads—usually secondary or private farming roads rather than main highways—by automobile and searching for obvious signs of nesting activity. Because the species' nests in colonies, such signs include: (a) foraging flocks, (b) flight lines of birds moving back and forth between the nesting site and foraging locations, and (c) birds either perching atop or milling about the actual nesting substrate. Detection of the latter activity was facilitated by stopping the vehicle every few minutes and carefully scanning with binoculars any potential nesting substrate within view. I generally avoided directing my searches to any specific nesting sites which have been identified by other workers during the 1990s. Instead, I concentrated on searching areas where I found colonies during the 1970s, or which appeared, based on my experience, to be potential breeding habitat today. An inherent assumption was that by following this survey approach, I would be likely to find all or most colonies (or any non-breeding flocks) that existed within each intensively surveyed area at the time of survey.

Table 1 lists areas searched and effort expended. Effort (mileage and time) relates to the amount of intensive surveying done while on secondary and private roads, and it generally does not include mileage and time expended while driving at highway speeds to and from the intensive search areas. Intensive surveying was done on 7 days, covered 1,053 miles and spanned 43.75 hours. Overall, portions of 13 Central Valley counties were surveyed.

My objective was to locate as many colonies as I could and assess their relative sizes—both the areal extent of nesting and number of nesting birds. Thus, when a colony was found, it was examined only long enough to determine nesting stage (i.e., singing/courtship, nest-building, egg-laying, incubation, feeding nestlings, or fledglings present) and size. Because of the Tricolor's unique breeding biology (i.e., depending on nesting stage, a variable percentage of a colony's total

**Table 1. Tricolored Blackbird breeding colony survey effort in the Central Valley, California, April-May 2000.**

DATE	LOCATION	MILES (ROAD) SEARCHED	HOURS SEARCHED
04-19	Stanislaus and Merced counties	70	2.50
04-20	Tulare and n. Kern counties	233	8.50
04-21	nw. Tulare, s. Fresno, & e. Kings counties	160	7.00
04-26	Sacramento County	200	9.00
05-01	Yolo, Sutter, Colusa, Glenn, & Butte cos.	225	8.50
05-02	se. Solano County; Yolo Bypass, Yolo County	58	2.50
05-04	n. Sacramento and w. Placer counties	107	5.75
	TOTALS	1,053	43.75

birds are present) a colony's number of birds was often a projected figure, based on assumptions of a 1(M):2(F) sex ratio and one active nest per female. If a colony was just establishing, and nests were not yet present, the estimated number of birds singing/courting on the nesting substrate and number in flocks in the immediate vicinity, were totaled to estimate total colony size.

In addition to my intensive colony search, I also visited five colonies that had been located earlier in the season by others. Specifically, I visited two colonies nesting in milk thistle on Merced National Wildlife Refuge (NWR) in Merced County on April 19, and two colonies—one in a cattail pond and one in a grain (dairy silage) field—southeast of Corcoran in Tulare County on April 20. These four colonies were visited in the company of William J. Hamilton III. Our purpose was to collaborate in jointly estimating numbers of birds and relative nesting success at the sites. Data from colonies Hamilton and I jointly visited will be reported elsewhere by Hamilton.

On May 5, I also visited one colony in the Natomas District of northwestern Sacramento County reported to me by coworkers in my office. Neither this nor the four colonies visited with Hamilton are included later in the tabulation of my intensive survey results. However, my observations at these five colonies were considered in developing the conclusions and recommendations presented later herein.

## RESULTS AND DISCUSSION

**April 19, 2000.** For several hours during mid-day, Hamilton and I collected data in the two

colonies on Merced NWR. One colony contained about 1,500 birds; the other had about 15,000.

Late in the day, Hamilton and I rendezvoused in Tulare County at a site about 10 miles southeast of Corcoran known as Toledo Pit. This colony, which is in cattails of an irrigation district's holding pond, has been active over recent years. Toledo Pit appears to be the only marsh within many miles. Earlier this season, Hamilton had estimated this colony's size at over 25,000 birds. We only briefly traversed through the colony to determine the present extent and stage of nesting. Hamilton planned to follow up in greater detail, including estimating current population size, the next day.

Because of my work with Hamilton for most of the day, my only intensive colony search on April 19 (in portions of Stanislaus and Merced counties) occurred in the morning while in route to Merced NWR. I found no colonies during the 70 miles and 2.50 hours of search effort (Tables 1 and 2). I did observe one small (20-25 adults) flock of Tricolors in an irrigated pasture next to a small dairy near the junction of Highway 165 and Highway 140. However, due to time constraints, I was unable to follow up to determine if these birds were associated with a nesting colony. Because of the very limited search effort within these two counties, a comparison of Tricolor breeding abundance today versus 25 years ago is not possible.

**Table 2. Summary of Tricolored Blackbird breeding colonies located during an intensive survey effort in the Central Valley, California, April 19-May 4, 2000.**

DATE	LOCATION	COUNTY	NO. BIRDS	STAGE OF NESTING	NESTING SUBSTRATE
4-20	6 mi. E Corcoran	Tulare	3,500	Establishing	Grain (Silage)
4-21	6 mi. E Corcoran	Tulare	4,000	Destroyed	Grain (Silage)
4-21	10 mi. N Corcoran	Kings	3,000	Establishing	Grain (Silage)
4-21	3 mi. NW Riverdale	Fresno	5,000	Fledging	Grain (Silage)
4-26	8 mi. NE Mather AFB	Sacramento	3,900	Incubating	Blackberries
4-26	Rancho Seco vicinity	Sacramento	375	Incubating	Blackberries
5-04	8 mi. S Wheatland	Placer	1,500	Establishing	Blackberries
		TOTAL	21,275		

Qualitatively, however, I can say that the area immediately south of Turlock, Stanislaus County, still has a fair amount of apparently suitable Tricolor foraging habitat—a complex of irrigated pasture and alfalfa fields intermixed among several small dairies. However, it was also clear this area has experienced considerable loss of such habitat to urbanization and conversions to

vineyards and orchards.

Vineyards and orchards provide universally low habitat value for Tricolors. This is because such crops provide no suitable nesting substrate and little or no foraging area, since like other blackbirds, Tricolors prefer to forage in open areas with relatively low (<6-inch-tall) vegetation which affords good visibility of aerial predators.

One encouraging note was my observation of the dramatic expansion over the past 25 years of managed wetlands in Merced County roughly between Turlock and Los Banos. Thousands of acres of refuge lands have been added in this region. The area is now a nearly contiguous refuge complex made up of three Federal NWRs (Merced, San Luis, and Kesterson), two state Wildlife Management Areas (Los Banos and Volta), and private lands under conservation easements. During my earlier study era, this refuge complex was a much smaller patchwork of lands.

Unfortunately, Tricolors have not, in my view, benefitted proportionally as much from this and other refuge complex (and private wetlands) expansions within the Central Valley as waterfowl and other waterbirds to which most of the wetlands restoration efforts have been directed.

Understanding this dilemma requires consideration first of the Tricolor's basic breeding needs. From my experience, I believe that ideal breeding habitat exhibits two key elements: (1) a dense nesting substrate such as blackberries or aquatic emergent vegetation which either in itself, or through management, provides suitable protection from predators until nestlings have fledged; and (2) a large supply of insects (*in* DeHaven et al. 1975b) in proximity to, and in synchrony with, the colony's production of nestlings.

We reported earlier that the insects most important for nestling provisioning included Coleopterans (ground-dwelling beetles, water beetles, and weevils), Orthopterans, Arachnidans, Hemipterans, and other larval insects (Crane and DeHaven 1977). Such insects are often driven from the ground and made available en masse to breeding Tricolors by shallow flooding. The most ideal shallow flooding occurs where livestock pastures of alfalfa, hay, grain, or native grasses, which have recently been cut or grazed to optimal height (i.e., <6 inches), are flood-irrigated to stimulate additional forage production.

Flooding of selected barren or sparsely vegetated refuge lands could have the same effect. Unfortunately, at the time large insect supplies are needed most by nesting Tricolors, most Central Valley refuge lands and private wetlands are either dry or already flooded (*see* below). Also, pastures (i.e., directed at livestock forage production) of optimal vegetative height are essentially non-existent on refuges. In fact, high-value (to Tricolors) pasture lands have often been the *source* of lands acquired and converted to managed wetlands. Thus, feeding values for Tricolors provisioning large numbers of young tend to be low on most refuges (although high-value off-refuge feeding sites sometimes occur nearby).

As currently managed, Central Valley refuges and private wetlands do sometimes incidentally

meet the Tricolor's need for high-quality *nesting substrates*, however. This usually occurs in conjunction with one of the three typical Central Valley managed wetlands types: permanent, semi-permanent, or seasonal wetlands (USFWS 2000).

Permanent wetlands are typically flooded year-round to a depth of 18-36 inches; semi-permanent wetlands are typically 6-24 inches deep and flooded from October through mid-July; and seasonal wetlands are typically flooded 6-12 inches deep from September through April (USFWS 2000). These are general guidelines developed over the years to benefit mainly waterfowl and other water birds. However, such management schemes generally provide little, if any, benefits in meeting the *foraging needs* of breeding Tricolors.

Moreover, I believe evidence of the problem can be corroborated through observation of the closely related Red-winged Blackbird (*Agelaius phoeniceus*). I would maintain that emergent vegetation and uplands areas on Central Valley refuges and managed wetlands typically support much lower densities of nesting Red-wings than most nearby off-refuge uplands and grain fields. Although I did not collect data to verify it, this difference was visually quite obvious during my 1970s work, and also during the current 7-day, 1,053-mile survey. The phenomenon of low breeding Red-wing densities on managed wetlands of the Central Valley is also likely related to low availability of insects needed for provisioning nestlings.

**April 20, 2000.** During the morning, Hamilton and I examined a colony located in Tulare County on the Tony Jorge dairy farm, about 10 miles southeast of Corcoran. About 7,500 birds were nesting in a wheat field mixed with nettles. We measured fledgling production and areal extent of nesting in this field. We were advised by the owner that the field was being grown for use as dairy silage<sup>1</sup> and would soon be harvested. This clearly presented a problem--and a situation which now regularly occurs in this area--since there were still thousands of nestlings within the nesting area.

I was subsequently informed that on May 3, 2000, just as the Jorge dairy colony *was* being harvested, Special (Law Enforcement) Agents from the Service's Sacramento Office arrived on scene. Some nestling and fledgling mortality due to the harvesting operations was documented. To prevent further mortality in possible violation of Migratory Bird Treaty Act provisions, agents directed that the harvesting operation be halted. This subsequently led to informal agreement between agents, (i.e., the Service) and Mr. Jorge, that the birds could be adequately protected if harvesting resumed only on or after May 12, 2000. The Service also pledged to assist in reimbursing the Jorge dairy \$500 for the loss of silage value<sup>2</sup> associated with this delay in harvest.

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<sup>1</sup>Any of various grasses and grains such wheat, barley, sorghum, and corn which are cut while green, compressed, and fermented to retard spoilage, then fed to livestock, especially dairy cows. In California, silage is often stored in compacted piles for up to several months before use as livestock feed.

<sup>2</sup>Dairy silage fields in this area are double-cropped, usually with a crop of corn immediately following the harvest of a crop of grain. Loss of value to the dairy arises in two ways: delay in planting the second crop, and loss

While in route to the Jorge dairy on April 20, Hamilton and I found another colony just establishing in another barley or wheat silage field in Tulare County, about 4 miles southeast of Corcoran. About 5,000 birds were present. Hamilton planned to make more detailed follow-up observations later. Since this too was a silage field, the likelihood of harvest before completion of the birds' nesting cycle was again a concern.

My intensive colony search in Tulare County and northern Kern County during the remainder of April 20 spanned 233 miles over 8.50 hours (Table 1). One colony was located (Table 2). This was another dairy grain (wheat/rye hybrid) silage field located about 6 miles east of Corcoran, Tulare County on Te Velde dairy property. Nesting at this colony was quite asynchronous, with some birds feeding young, while other groups were either egg-laying, singing and displaying, or starting to construct nests. Although I observed only about 3,500 birds on this date, I learned later from Hamilton that the colony had grown much larger with the arrival of additional waves of birds.

Because of its large size and thus the potential for a large loss of Tricolor production associated with imminent silage harvesting operations, on May 9, 2000, Service (including Law Enforcement) and Te Velde representatives met and agreed to a 3-week delay in harvest. This agreement was tied to the reimbursement of \$32,616 in lost value to Te Velde associated with the harvest delay<sup>1,2</sup>.

Overall, my Tulare County/northern Kern County search illustrated several important contrasts to my earlier studies in the 1970s. First, there has obviously been a significant increase in dairy operations in the western portion of this area which may be benefitting (because of related forage and silage production) Tricolor nesting (but not necessarily recruitment), as evidenced by the relatively large number of colonies now regularly occurring in the vicinity of Corcoran. My earlier work (DeHaven et al. 1975b) produced just one 1,500-bird colony in Tulare County in 1971 (although nearby in Kings County we found a 25,000-bird colony the same year). Second, there has clearly been conversion of substantial acreage in the eastern part of this area to vineyards and orchards (various fruits and nuts), causing a resultant loss of Tricolor habitat. And third, it appears that at least some of the increases in both dairy-related agriculture and grapes/orchards have been due to conversions from cotton fields, another form of non-habitat for Tricolors.

**April 21, 2000.** My search of northwest Tulare County, southern Fresno County, and eastern Kings County spanned 160 miles over 7.00 hours (Table 1). Three more nesting colonies were found (Table 2), and each was associated with a dairy.

The first site was a 4,000-bird colony about 6 miles northeast of Corcoran, Tulare County. When

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of nutritional value if the first (grain) crop is not harvested at optimal moisture content. Thus, the longer the delay in harvest from the optimal harvest date, the greater the monetary loss to the dairy.



I found this site at 0815 hours, a fleet of seven cutters (combines) and 10 trucks was just completing harvest of the nesting substrate--another silage field composed of barley and tall (>5 feet) mustard. The few nests not yet destroyed contained mostly 1-3-day-old nestlings; thousands of adult birds were milling about the site in a confused manner or foraging nearby in other recently cut hay and/or silage fields.

About an hour later I found a second colony about 10 miles north of Corcoran in Kings County. The situation here was similar--with the nesting substrate of wheat or barley having just been harvested. This second colony had about 3,000 total birds milling about or feeding in the adjacent dairy (D&T) and in other nearby, recently cut hay and silage fields.

About noon I located a third colony, about 3 miles northwest of Riverdale in Fresno County. This colony had about 5,000 birds. It was also adjacent to a dairy (Monteiro Brothers). However, unlike the two earlier colonies, the young were already fledging and there was no indication of any impending silage harvesting operation. The nesting substrate at this site was a very dense mixture of wheat and nettles.

Overall, my 2-day survey in parts of Tulare, Kings, and Fresno counties demonstrated, as other workers (e.g., Hamilton et al. 1999) recently have, the high importance today of dairy silage (grain) fields as nesting substrate for Tricolors within this region. This association with dairies is clearly much more important today than during my earlier study era (*see*, however, footnote 6 on page 17). In particular, our earlier report (DeHaven et al. 1975b), listed 156 total colonies found from 1968-1972. Of these, 108(69%) had nests built in some kind of marsh vegetation--cattails, bulrushes, willows, or some combination of these, and 76(49%) were in cattails alone. We did not find any of the 1970s colonies in grain fields, although some were reported earlier by Neff (1937). In contrast, five of five colonies (including the one found with Hamilton) I found on April 20-21, 2000 were in dairy grain silage fields associated with large dairies.

Today's utilization of grain silage fields as Tricolor nesting substrate is thus both surprising and thought-provoking. Among questions which arise are: 1. Have the taller stature and more robust physical characteristics of the particular grain varieties (and cultural practices) used today for dairy silage production made such crops more attractive as nesting substrate than similar non-silage grain fields, or silage fields grown in the past? 2. Has the obvious dairy expansion in this part of the San Joaquin Valley, where many individual operations now exceed 500 cows, benefitted Tricolors to the extent that suitable natural and traditional breeding sites (e.g., marsh vegetation such as at Toledo Pit) are fully utilized, thus forcing birds to utilize more grain fields grown for silage? 3. Does the common practice of dairy farmers harvesting such grain silage fields while they are green and before Tricolor young have successfully fledged and departed the field pose a significant biological threat to the species?

Deriving definitive answers to these and related questions will demand much additional research. Nevertheless, some brief comment here with regard to the last question is appropriate: I believe we must be cautious in assuming a positive relationship between the Tricolor's decline (DeHaven

et al. 1975b; Beedy and Hamilton 1999) and the mortality issue relating to dairy silage field harvesting. Because of the Tricolor's colonial breeding in which thousands of birds can be present in one colony, there may be a natural tenancy to assume biological significance related to a large nesting failure without fully considering the species' biology and ecology.

First, it is unlikely that many breeding adult Tricolors are directly injured or killed by silage harvesting operations. Clearly, they would be able to avoid the machinery and operations under most conditions. Only nests, eggs, nestlings, or very young fledglings (depending on nesting stage at harvest) are likely subject to direct injury or mortality, and this no doubt varies widely, depending on many factors and conditions. Certainly, a worst-case scenario in which thousands of Tricolor eggs or young have been knocked to the ground and/or compacted into fermenting bales of cow forage is an objectionable picture, but its relative overall biological significance is quite another matter.

During my earlier study era, we concluded based on our years of qualitative observations that it was common for Tricolors to travel from place to place, perhaps in somewhat of a regular circuit or pattern, during the breeding season. The general picture we gathered was that of large, semi-nomadic congregations of birds nesting, renesting, and intermingling, until at least one (and possibly more) successful nesting occurred. We commonly observed colony abandonment and renesting in response to massive nesting failures from a variety of causes, including predation, lack of sufficient food resources, human disturbance, and other factors. Unfortunately, these 1970s studies were not designed to generate quantitative data to confirm or reject this "itinerant" breeding model of the species.

However, this issue has recently been carefully addressed by Hamilton (1998), who, based on several years of breeding data, has confirmed—at least for the Central Valley—the Tricolors' itinerant breeding. An important implication of itinerant breeding is that very low reproductive successes observed in some habitats does not necessarily make these habitats reproductive sinks. The key issue is *seasonal* reproductive success, which is the sum of all incremental successes. At some threshold level, the metapopulation probably becomes sustainable, despite seemingly trivial additions from certain habitats, times, and places (Hamilton 1998).

Although itinerant breeding has been confirmed, much important related information is still lacking. What limit exists on nesting attempts per season? Beyond what thresholds of nesting attempts or seasonal phenology does repeat nesting result in a reproductive sink? Such questions can probably best be answered through a combination of detailed histological studies of post-ovulatory follicles of females and intensive marking and tagging (or radiotelemetry) studies of adults of both sexes, beginning early in the breeding season.

Nevertheless, given this species' itinerant breeding behavior, the past practice of compensating farmers to delay or forego dairy silage field harvesting to protect nesting birds is, at best, of questionable biological value. This practice should be (a) considered only an interim approach for use until a long-term management strategy can be implemented to ameliorate the silage harvesting

problem, and (b) then used only when very strict criteria are met to ensure the highest possible value to the species (i.e., fledgling production) at the lowest possible cost. High value and low cost may require focusing on colonies with relatively large numbers of birds breeding very synchronously in small areas. Related criteria, such as where the breeding birds are feeding and the expected nesting stage at projected time of harvest, are equally important.

Aside from occasional use in very strictly defined instances, dairy farmer compensations should be abandoned, and the funds redirected towards long-term, biologically sound, "hands-off" management strategies. Elements of an effective long-term strategy (DeHaven 2000) should include: (a) creating additional, strategically located natural nesting substrates (e.g., cattails, bulrushes, or blackberries, or combinations thereof) of high quality within the area, (b) identifying the primary element(s) of attractiveness associated with today's grain silage fields (e.g., height or other physical factors), and working to eliminate or restrict their deployment by dairies within the area, and (c) employing selective hazing (e.g., propane exploders or pyrotechnics) operations when and where necessary to prevent large Tricolor nesting attempts in the most unfavorable dairy silage field situations, while encouraging such nesting in more favorable situations.

**April 26, 2000.** My survey of Sacramento County, with a focus on the southern portion, covered 200 miles over 9.00 hours (Table 1). I located only two colonies (Table 2), both nesting in Himalaya blackberries. The first colony, containing about 375 birds, was in a dry grassland area near the decommissioned Rancho Seco nuclear power plant. The second colony, with about 3,900 total birds nesting in eight scattered clumps of blackberry, was near the entrance to the Prairie City Offroad Vehicle Park, about 8 miles northeast of Mather Air Force Base. Other than the birds associated with these two nesting groups, I observed no other Tricolors during the survey.

These findings<sup>3</sup> indicate a greatly reduced Sacramento County breeding population in contrast to my 1970s work. For example, our earlier efforts resulted in an average of more than seven colonies per year totaling up to about 51,000 birds (DeHaven et al. 1975b), and we commonly observed many large flocks of Tricolors each year throughout the area. Moreover, the earlier annual search efforts were always much less intense than this year's effort. This was largely because we always easily located, within an hour or two, several large colonies where the focus of our activities (banding and food-habits studies) could be conducted.

The massive loss of Tricolor habitat that has occurred within Sacramento County over the intervening 25-30 years was striking. Urban expansion has consumed thousands of acres, especially in Elk Grove (and vicinity), the Natomas Area, and in the vicinity of Twin Cities Road in Galt. In addition, large areas of Tricolor habitat have been converted from pastures associated with small dairies (and from row crops), to grape vineyards. Sacramento County's grape acreage

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<sup>3</sup>Note: I may not have located *all* Sacramento County colonies in 2000. A few small breeding sites that I did not locate were subsequently found and reported to me by Liz Cook. However, my observations, and discussion here relate to *my overall* findings and observations for 2000 versus the 1970s, and are thus still considered valid.

has expanded by an astonishing 75% in just one recent 2-year period from 1996 (7,533 acres) to 1998 (13,176 acres; California Agricultural Statistics Service<sup>4</sup>=CASS). This is nearly double the 41% rate of increase for grapes statewide for the entire 10-year period from 1989 (561,429 acres) to 1998 (794,034 acres).

Clearly, if the present Sacramento County conversion rate to vineyards continues (or accelerates), another huge area of Tricolor breeding habitat will be lost in just a few years. This coupled with the inevitable loss of more habitat to continued urban expansion, will likely preclude the Tricolor from anything other than a token breeding presence, at best, in the County within the next 10-25 years—or less.

An essential precursor to stabilization and long-term maintenance of the metapopulation of this species at some lower (but as yet unspecified) level is to identify and understand the land-use trends (such as those involving conversions to grapes) in relation to the species. The kind of land-use data cited above for grapes should be broadly collected and evaluated down to county and even smaller geographic units whenever possible. Understanding present land-use trends and predicting future trends are essential for most efficiently and effectively directing Tricolor management decisions and dollars. Efforts can and should be directed to the areas with the highest probabilities of long-term maintenance of populations.

**May 1, 2000.** My search of the rice district north of Sacramento, including parts of Yolo, Sutter, Colusa, Butte, and Glenn counties, comprised 225 miles over 8.50 hours (Table 1). I found neither any nesting birds (Table 2) nor any non-breeding flocks, despite searching most of the habitat (i.e., including Sycamore Slough vicinity, Colusa NWR, Sutter Buttes vicinity, Butte Sinks vicinity, Gray Lodge WMA, Gridley Road, Princeton Highway, Afton vicinity, Sacramento NWR, Norman Road vicinity, Four-mile Road vicinity, Delevan NWR, and Lurline Road vicinity) where the species was always quite common during the 1970s.

To illustrate further, over 72% of the 33,058 Tricolor nestlings we banded during our earlier studies (DeHaven et al. 1975a) were from large colonies mainly within this rice district. The estimated total number of breeding birds we found annually in rice district counties during 1969-1972 ranged from a low of 32,000 to a high of 105,000 (DeHaven et al. 1975b). The variable percentage (29-59%) of total breeding Tricolors found in rice district colonies during 1969-1972, was probably the result of the species' itinerant breeding behavior which has recently been confirmed by Hamilton (1998).

To my surprise, I did find the rice district to be relatively unchanged compared to the 1970s. The most significant change observed was the obvious expansion—just as in Merced County—of refuge lands and privately managed wetlands. However, as previously discussed, I maintain that

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<sup>4</sup>All crop acreage and trend data presented herein are from statistics available on the CASS web site at [www.nass.usda.gov/ca](http://www.nass.usda.gov/ca) on April 24, 2000.

Tricolors have not benefitted (at least for breeding) from wetlands expansions—either on public refuges or private lands—to same degree as waterfowl and other water birds to which wetlands restorations and expansions have been primarily directed.

My May 1 survey indicated that rice is still the overwhelmingly dominant crop in the area. This is confirmed by statistical data showing that in 1998, total rice acreage for the State was 480,000 acres<sup>4</sup>. Moreover, during the preceding 9 years from 1989 to 1997, the total State acreage of rice ranged from 351,000 acres (1991) to 518,000 acres (1997). These figures are quite similar to the range of rice acreages occurring during the 1970s.

Although acreages of rice have remained relatively stable over the past quarter century, large expanses of this crop do not necessarily present good foraging opportunities for breeding Tricolors—and in fact, may today be counterproductive for the species. For one thing, abundant insect supplies necessary for provisioning chicks are generally available for only brief periods in the spring (April and early May) as rice fields are actually first being flooded preparatory to aerial seeding. The progression of flooding across dry fields does sometimes drive insects from the ground en masse. However, barren (disced) or flooded rice fields otherwise present little, if any, foraging opportunities for nesting Tricolors.

Another important issue relative to Tricolors and the rice crop is fall and winter conditions after the rice fields are harvested. Both harvesting operations and post-harvest management of rice fields have changed dramatically over the years, most likely to the Tricolor's detriment.

From the time rice was introduced in the State early in the century to about the mid-1980s, rice fields were commonly burned in the fall following harvest. This practice resulted in abundant fall-winter food resources for blackbirds and other birds including waterfowl, in the form of waste rice seeds remaining on the ground in harvested fields. And burning of fields reduced or removed the rice straw, thus providing the open foraging conditions preferred by blackbirds. As a result, in the Sacramento Valley during the fall and winter months of the 1970s, we commonly observed huge foraging flocks of mixed blackbird species (including large numbers of Tricolors) foraging in burned rice fields. Such flocks commonly contained tens of thousands of birds.

Conditions today are much different. Miller and Wylie (1996) have reported that in the past (i.e., until about the mid-1980s), rice fields harvested with conventional cutter-bar headers which cut off the rice heads, left rice stubble behind (which was burned) and rice waste grain on the ground totaling about 388 kg/ha. Today, use of cutter-bar headers has been largely replaced by new, faster technology called a "stripper header" which strips the seeds from the rice head. Although stripping results in roughly the same amount of waste rice remaining in harvested fields (Miller and Wylie 1996), it is much less available to blackbirds, because of the taller stubble left standing. This problem (for blackbird foraging) is further exacerbated because burning, which clears and opens fields, is being phased out because of environmental concerns. Moreover, an increasing amount of rice acreage is now being flooded in the fall following harvest. This provides high-value water bird—especially waterfowl—habitat, but generally precludes any significant foraging by

blackbirds.

Clearly, the specific issue of waste rice grain availability and the overall issue of fall-winter food resources and availability for blackbirds in the Central Valley, including Tricolors, need further study. How these factors may relate to the Tricolor's observed population decline have not yet been considered. Problems for this species may not only be related to breeding, as is being commonly assumed.

A closely related issue which also merits further study is interspecific competition for fall-winter food resources as it may relate to the Tricolor's decline. Throughout the present 7-day survey, I was struck (i.e., compared to the 1970s) by the highly ubiquitous, dense distribution of nesting Red-winged blackbirds<sup>5</sup> throughout the Central Valley. It appeared that nearly all available upland nesting areas, including grain (silage and non-silage) fields, were occupied by this species. Thus, Red-wing numbers today in the Central Valley clearly must total many millions of birds, perhaps making them much more abundant than in the past. If so, Red-wings have the potential to out-compete Tricolors for limited fall-winter food supplies when both of these species, and other Valley blackbird species, share large (>1 million bird) communal roosting sites and foraging flocks. Studies of these roosts in the Valley and Sacramento-San Joaquin Delta are warranted. Such studies should include food-habits evaluations and bioenergetics analyses and calculations, such as have been done for the Valley's waterfowl populations.

**May 2, 2000.** The May 2 survey was relatively brief (58 miles over 2.50 hours; Table 1), focusing on southeastern Solano County and the Yolo Bypass area (Highway 80 north to Highway 5 only) of Yolo County. Neither any Tricolor colonies nor non-breeding Tricolors were observed.

I was both surprised and encouraged by the relative similarity of southeastern Solano County to conditions during the 1970s. This area still has what appears to be an abundance of good Tricolor breeding habitat—large acreages of both dry grasslands and irrigated pastures, scattered alfalfa and hay fields, relatively low acreages of truck and row crops, light-to-moderate livestock grazing, and potential nesting substrates (marshes and blackberries) scattered throughout the area. Thus, the lack of any Tricolors was also somewhat surprising. The Service is proposing a new refuge—the North Delta NWR—in this area, which could, if implemented, lead to opportunities to restore, enhance, and preserve Tricolor breeding in this area.

What appears to be favorable breeding habitat, including nesting substrates, pastures, and various wetlands constructed in recent years by the City of Davis and Conaway Ranch, also exists along the Bypass. Tricolors have nested here in recent years, but none were observed by me on this particular survey date.

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<sup>5</sup>Identified by the presence of adult territorial males perching atop prominent vegetation within their territory. Generally, two to four nesting females are associated with each male's territory.

**May 4, 2000.** My final day of survey on May 4 covered 107 miles over 5.75 hours (Table 1) in western Placer County and northern Sacramento County. I located one colony of 1,500 birds (Table 2) nesting in blackberries near the junction of Brewer and South Nicolaus roads in Placer County. I also observed a flock of 50 adult Tricolors feeding in a flooded pasture about 6 miles south of the 1,500-bird colony (and thus assumed to be associated with it).

My general impression of Placer County was that substantial areas of good breeding habitat still remain. On the other hand, loss of good habitat to urban development has clearly been substantial, especially in the corridor from Roseville to north of Lincoln (e.g., the Del Web Sun City retirement community), and this loss is likely to continue, because Placer County has one of the highest urban growth rates of any county in the State.

I also visited the Natomas District colony, which is on a 330-acre parcel recently acquired in northwestern Sacramento County by the Natomas Basin Conservancy. The Conservancy is acquiring and managing lands under guidance of a Habitat Conservation Plan (HCP) for fish and wildlife to offset impacts of urban development in the Natomas District (*also called* Natomas Basin).

The Natomas colony contained an estimated 4,000 Tricolors nesting in five scattered clumps of blackberry. Nesting was quite synchronous, with the birds singing, displaying, and just starting to construct nests. In addition, prior years' nests were present substantiating its prior usage.

This colony and the surrounding 330-acre parcel are, in my opinion (and as *currently* being managed), a showcase example of high-quality Tricolor breeding habitat. The blackberries are dense, robust, and scattered about in several locations. The surrounding area is irrigated pasture, which appears to be managed in distinct parcels or "checks," thus allowing a "roving" or sequential flooding regime at the time Tricolors are nesting. A good, year-round, nutrient-rich supply of irrigation water appears to be coming from an adjacent fish (sturgeon) farm. Some or all of the pasture checks appear to have been lightly to moderately grazed by sheep or cows, which likely enhances insect production and creates optimal foraging (vegetative) height for the birds.

The most obvious concern regarding the Natomas site is: Will it be enough? Will the few hundred acres be enough contiguous land to fully support all the needs of a vigorous Tricolor breeding colony on a long-term basis once most or all of the surrounding area becomes more highly urbanized? The answer may only be found with time. In the interim, any efforts which would expand this area or create others like it nearby, should be undertaken to the extent feasible and consistent with the HCP.

My only other recommendation for further enhancement of the Natomas site for breeding Tricolors would be for conversion (to the extent that it can be done consistent with the HCP) of a portion of the checks to rotations which include alfalfa and/or hay crops. However, this would require careful adaptive management to ensure that the alfalfa or hay was mowed (and removed),

then shallowly flooded, in a proper roving rotation timed to meet the feeding requirements (adult foraging and nestling provisioning) of the species. Such a management regime could have high values for a wide range of other birds besides Tricolors. Birds known to utilize flooded alfalfa and hay fields include ducks, geese, raptors, herons, egrets, and other wading and shorebird species.

Alfalfa grown to *benefit* Tricolors and other birds (instead of for maximum profit) would not need, and should not have, any intensive pest control management. Pest control, especially control of alfalfa weevils and other crop-injurious insects, could be quite counterproductive for breeding Tricolors. In fact, existing entomological knowledge of insect pests in alfalfa and hay crops should be tapped for ways in which to benefit Tricolors. We should be asking this basic question: How can insects be *increased* in density and abundance for the benefit of Tricolors and other target species?

**Overall Comparison: 1970s Versus 2000.** During studies in the 1970s, we found an average of 41 colonies a year totaling an estimated average of 133,000 nesting birds. We also observed an average of over 3,700 unattached birds annually during colony searches (DeHaven et al. 1975b).

My brief 2000 survey found seven colonies totaling 21,275 birds and one small group of 20-25 unattached birds. These are probably overestimates of what a more unbiased comparison and search of available habitat would have produced. My search was biased by focusing much of the effort in the large dairy complex of the southern San Joaquin Valley, due to its reported high importance to Tricolors over recent years. The more unbiased portion of my search effort, *excluding* this large dairy complex, yielded just three colonies totaling 5,775 breeding birds.

These quantitative results and my qualitative observations during the 2000 survey are consistent with a conclusion of another large increment of population decline in the Central Valley for this species between the 1970s and today. In combination with the conclusions of the 1990s workers that the species is continuing in decline in this era (Hamilton et al. 1999; *in* Beedy and Hamilton 1999)<sup>6</sup>, the need and urgency for implementing effective management strategies is thus further reinforced.

Although my 2000 survey is useful in evaluating long-term trends and is suggestive of relative overall Central Valley population size, it cannot be extrapolated to any overall Central Valley breeding population estimate. This task is being ably accomplished by the 1990s workers through annual statewide breeding population surveys conducted for each of the past several years. Their most recent statewide survey reported a breeding population decline to about 105,000 birds in 1999 in contrast to over 350,000 recorded in 1994 (Hamilton et al. 1999)<sup>6</sup>

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<sup>6</sup>Preliminary 2000 survey results, however, are indicating a larger population figure than reported for 1999.



**The Predation Issue.** The 1990s workers have directed considerable attention to their observations of high rates of predation, often to the result of complete reproductive failure at certain colonies (Hamilton et al. 1999). In particular, they have described most cattail marshes in the Central Valley, including marshes on refuges and in association with rice fields, as being universally low in reproductive success (i.e., reproductive "sinks") for Tricolors, largely because of their propensity for high predation losses due to Black-crowned Night Herons (Hamilton et al. 1999).

What remains unclear, however, is whether such heron (and other predator) losses are within ranges normally (and historically) expected of such a colonial nesting species, or whether this is, like the relatively new dependence of Tricolors on large San Joaquin Valley dairies<sup>7</sup>, a new phenomenon to be dealt with. I can say from my 1970s work that we commonly observed such high predation as is being reported for the species during 1990s.

But if the high predation being observed today is indeed a new and unnatural phenomenon, what is its underlying cause? Have heron populations dramatically expanded? Are there simply more predators overall today?

I submit that we should also be examining whether, in the situations just described, lack of adequate insect food supplies in juxtaposition with these breeding substrates may be an important factor interconnected with predation. Poor feeding conditions may alter breeding behavior in numerous ways, which in turn may increase site-specific predation. For example, adults may be leaving nests and chicks unattended for longer periods (while food is pursued), and nestling growth rates may be significantly slowed, thus prolonging periods of predation susceptibility.

Another possibility is a sequential link: poorer feeding conditions, which may have reduced colony sizes, which may have increased predation impacts. In other words, has the evolutionary benefit (i.e., of protection against reproductive failures due to predation) to the species of huge breeding colonies which formerly contained up to several hundred thousand birds (Neff 1937) been reduced or negated because birds must now generally breed in much smaller colonies (due to poorer feeding conditions)?

Thus, predation as it relates to feeding conditions is yet another area of Tricolor ecology in need of further intensive study. The real significance of predation must ultimately be addressed in view of the species' itinerant breeding (Hamilton 1998), including the consideration that seasonal reproductive success is the sum of all incremental within-season successes. The biological significance of today's predation also depends on the Tricolor's capabilities with respect to

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<sup>7</sup>Here, I am *assuming* this to be a relatively new phenomenon. However, in reality, it is difficult to say *when* this dependence on silage/dairy operations began, since most earlier workers, including myself, spent relatively little time studying Tricolors in Tulare, Fresno, Kings, and Kern counties, where the relationship appears to be most pronounced.

renesting attempts per season—yet another research need of utmost importance.

## CONCLUSIONS

As measured by their breeding abundance, Tricolored Blackbirds have experienced a long-term population decline which continues today. Much of this decline stems from losses of breeding habitat to urban expansion and changes in agricultural land uses. Conversions of pasturelands, both irrigated and non-irrigated, and hay crops (alfalfa and others) to vineyards and orchards has been, and will likely continue to be, one of the most damaging forms of land-use change.

Because of the severe losses of habitat, which are likely irreversible<sup>8</sup>, there is little likelihood that any historic population level—or indeed, even a more recent level—can ever be restored and maintained. The most realistic goal is to strive to stabilize and maintain the Tricolor metapopulation at some lower, but as yet unspecified, level. This will require immediate action now on many fronts, including conducting research into the many unanswered questions which persist regarding this species' ecology as it may relate to the observed population decline.

The relatively recent phenomenon of much of the remaining world population breeding in association with large dairy operations in the San Joaquin Valley<sup>7</sup> presents both one of the more serious threats and one of the best hopes for the species' future. The threat is from continued, perhaps even larger, reproductive failures and sinks associated with silage harvesting. Hope is through (a) potentially large increments of reproductive output—if the silage harvesting problem can soon be resolved, and (b) possible long-term stabilization of existing, high-value Tricolor habitat associated with these large dairies. Large dairies generally have large capital investments and good profitability which may insulate them from susceptibility to land-use conversions to grapes, orchards and other agricultural uses with low or no habitat values for Tricolors.

However, keying on large dairies as an approach to stabilizing and maintaining the Central Valley Tricolor population will necessitate both close coordination with, and the support of, the dairy industry in the involved San Joaquin Valley counties.

## RECOMMENDATIONS FOR ACTION

The 1990s Tricolor workers have provided many useful and well-thought-out recommendations in their various reports and publications. My purpose here is neither to supercede nor repeat their efforts. Instead, I have attempted to coalesce some of their key recommendations with my own thoughts and observations into several clear, concise steps for immediate action. These are steps

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<sup>8</sup>I assume here that habitat losses to urbanization will be totally irreversible. Losses to vineyards and orchards, and other undesirable agricultural land-use changes could *potentially* be reversible if an unforeseen and unusual major event, such as proliferation of a new pest or disease, made continuing a particular agricultural use economically unviable.

(not necessarily in order of priority<sup>9</sup>) that the Service and California Department of Fish and Game can undertake jointly or in concert with other concerned individuals and organizations in an effort to halt and stabilize the Tricolor's downward trend, and preclude the need for its eventual listing.

1.     **A.** Prepare a written plan to create additional, strategically located natural (including exotics, if necessary) nesting substrates [marshes, blackberries, giant cane (*Arundo* spp.), etc.] for Tricolors as alternatives to grain silage field substrates in the appropriate large dairy regions of the southern San Joaquin Valley, and **B.** begin implementing such a plan, if feasible. Include a stepwise approach to implementation and adaptive management to help ensure effectiveness of the strategy is demonstrated before committing to full implementation.
2.     **A.** Prepare a written plan for enhancing and managing in perpetuity the Tricolor breeding site known as Toledo Pit, 10 miles southeast of Corcoran, Tulare County, **B.** convert essential plan elements into a written conservation easement, **C.** attempt through negotiations with, and payment to, the landowner (water district), to put the easement in force on the property, and **D.** then, using this as a guide, follow-up with similar actions elsewhere in a widespread easement effort in major dairy regions supporting breeding Tricolors.
3.     Prepare a written land-use trends and projections analysis specific to the Tricolor, with a view towards prioritizing the key geographic and site-specific areas where funds can best be spent to achieve long-term preservation and enhancement of Tricolor habitat.
4.     **A.** Prepare a written Tricolor management and enhancement plan specifically for NWRs, State Wildlife Management Areas, and private wetlands in California, which includes appropriate checklists of key management elements, and **B.** distribute and implement use of this plan throughout the Tricolor's range (and especially in the Central Valley) to the extent feasible.
5.     Prepare written criteria which shall be followed in considering any actions involving monetary payments to dairy farmers for delaying or foregoing harvest of silage crops to benefit nesting Tricolors, with a view towards maximizing the cost-benefits and ensuring that this practice is minimized and discontinued within a reasonable time.

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<sup>9</sup>Priorities, as well as additional recommendations, should be established through the venue of a Tricolor management team.

6. A. Conduct and report on research<sup>10</sup>, through use of either agency staff, contractors, or university graduate students in pursuit of advanced degrees (supported through stipends, grants, scholarships or other means; the preferred approach to minimize costs) on the following issues (in *tentative* order of priority), and B. coalesce pertinent findings in a timely manner into appropriate additional management guidelines and measures:
- a. Evaluate the number of nesting attempts by Tricolor females per season based on evaluation of post-ovulatory follicles and/or uniquely marked or radio-tagged individuals, with a view towards identifying threshold criteria after which seasonal reproductive failures become important as drains on the metapopulation.
  - b. Identify characteristics of grain silage fields in use today which attract Tricolors for nesting, and evaluate feasibility of various measures (including plant genetics and hazing approaches) for making such fields unattractive, particularly particularly when used in combination with the creation of alternative natural nesting substrates.
  - c. Identify the foraging characteristics (for nestling provisioning) of Tricolors in successful and unsuccessful colonies, with a view towards characterization and management of ideal foraging areas and conditions (i.e., how, on managed lands, might insect production beneficial to Tricolors best be enhanced?)
  - d. Describe winter roost ecology of Tricolors, including numbers of birds, with a view towards determining whether winter food supplies and interspecific competition have become population-limiting factors.
  - e. Determine breeding site fidelity and philopatric characteristics of adult Tricolors in the Central Valley and selected extant areas using uniquely marked and/or radio tagged individuals, with a view towards comparison to previous findings reported from banding studies of Tricolor nestlings.
  - f. Determine mortality rates and survivorship of Tricolors through literature review, analysis of all previous Tricolor banding data, and through a large, new banding program.
  - g. Determine the relationships and degree of interchange between Central Valley Tricolors and those in extant locations, particular in southern California, through additional banding and/or radiotelemetry studies in combination with genetic DNA

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<sup>10</sup>Note: This is an initial list of the highest-priority issues, and is not all-inclusive. As new information is generated, this list should be appropriately revised and/or expanded, probably at least annually.

analyses.

- h.** Repeat the survey reported herein annually, including revising and refining the recommendations.
- i.** Include the findings herein in other Service actions, including Habitat Conservation Plan development and comment.

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