PURPLE MARTIN SURVEY RESULTS AT TEJON RANCH IN THE TEHACHAPI MOUNTAINS OF CALIFORNIA

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ABSTRACT: The Purple Martin (*Progne subis*), a species of significant conservation concern in California, once nested widely in oak, sycamore, and coniferous woodlands throughout the state. Currently, the Tehachapi Mountains of southern California are the only area where significant numbers of Purple Martins are known to still nest in oaks. We surveyed for the Purple Martin and other cavity-nesting birds on a portion of Tejon Ranch in the Tehachapi Mountains during summer 2010. We found 23 nesting pairs of Purple Martins, all using cavities in large Valley Oaks (*Quercus lobata*) at or near the tops of ridges in open savanna settings. The Acorn Woodpecker (*Melanerpes formicivorus*) was the most abundant other cavity nester in the area and likely creates the cavities used by Purple Martins. The European Starling (*Sturnus vulgaris*), considered a serious competitor of the Purple Martin for nest sites in most of the Purple Martin's range, was rarely encountered near these nest sites.

The Purple Martin (*Progne subis*), North America's largest swallow, is an aerial insectivore and obligate cavity nester. It is a sparsely distributed summer resident along the Pacific coast of North America, where it uses of a wide range of nest structures including tree cavities, nest boxes, lava tubes, bridges, and utility poles (Kostka and McAllister 2005, Airola and Williams 2008). In California, Purple Martins historically nested throughout most of the state except in the high Sierra Nevada and desert regions east and southeast of the Sierra. The Purple Martin's current range in California has shrunk considerably, particularly in the northern Central Valley, the coastal foothills, and locally in the Sierra Nevada and Cascades (Airola and Williams 2008). While habitat loss may have contributed to the decline of the Purple Martin in parts of California, competition with the non-native European Starling (*Sturnus vulgaris*) is considered the main threat (Williams 1998, Airola and Williams 2008). The California Department of Fish and Game currently considers the Purple Martin a species of special concern because of reduced range and declining population (Airola and Williams 2008, Airola and Kopp 2009).

In California, most Purple Martins breed in conifer forests, but they also use oak and riparian woodlands with sycamores (Williams 1998). Historically, oak woodlands were considered to be second to coniferous forests in their importance to Purple Martins (Miller 1951). In his review of the species' status in California, Williams (1998) found that Purple Martins were formerly widespread in oak woodlands, occurring in at least 15 counties, but by the 1990s occupied only a small fraction of these woodlands within one or two counties. He concluded that the Tehachapi Mountains may be the last place in the state where large numbers of Purple Martins still nest in oak woodlands and estimated that 100–200 pairs—about 15% of the

California population—could breed there (Williams 2002).

The Tehachapi Mountains are primarily privately held in ranchlands with limited access for bird observation. Therefore, the Purple Martin's distribution there is poorly known. Williams (2002) surveyed Bear and Cummings valleys in the northern Tehachapis in 2000 and found 57 nests in open Valley Oak (*Quercus lobata*) woodlands. In the late 1800s and early 1900s, Purple Martins were collected near old Fort Tejon (on the western edge of Tejon Ranch) in the southern Tehachapis (Grinnell 1905, Zwinger 1986), but until our work Tejon Ranch had not been the object of a broad-scale quantitative survey for the Purple Martin. Tejon Ranch covers nearly half of the Tehachapi Mountains and supports a vast area of oak woodlands that may be suitable for breeding by the Purple Martin and other cavity-nesting species. Our objectives were to survey a large area of Tejon Ranch potentially suitable for nesting Purple Martins, evaluate Williams' (1998 and 2002) estimate of the population in the Tehachapi Mountains, and document the distribution and abundance of the European Starling and other cavity nesters in this area.

STUDY AREA

Tejon Ranch is in the Tehachapi Mountains, California (Figure 1). At 109,000 ha, the ranch is the largest contiguous area of private property in the state. Tejon Ranch was the subject of the 2008 Tejon Ranch Conservation and Land Use Agreement between the Tejon Ranch Company, the property owner, and five environmental organizations (Audubon California, Endangered Habitats League, Natural Resources Defense Council, Planning and Conservation League, and Sierra Club). The agreement resulted in permanent conservation of 58,700 ha and options to purchase conservation easements over an additional 25,100 ha (which were executed by the Tejon Ranch Conservancy in February 2011). Our study was restricted to a portion of the 83,800 ha of conserved lands at Tejon Ranch (Figure 1) as discussed below.

Our field study focused on oak and mixed oak habitats within Tejon Ranch between 430 and 1830 m elevation. Tejon Ranch supports a high diversity of oak species, but our study area is dominated by the Blue Oak (*Q. douglasii*), Valley Oak, California Black Oak (*Q. kelloggii*), and Canyon Live Oak (*Q. chrysolepis*), each of which forms distinct communities depending on elevation, aspect, and other physical factors. Valley Oaks occur across a wide range of elevations but are rarely found on steep north-facing slopes. In Tejon Ranch, Valley Oaks most often constitute an open savanna. Blue Oaks are restricted to lower elevations and gentler slopes, varying in structure from open savannas to denser woodlands. Black Oaks occur at higher elevations and are often mixed with White Fir (*Abies concolor*); Canyon Live Oaks occur on steep and north-facing slopes. The Black Oak and Canyon Live Oak typically occur in dense woodlands or closed forests (>40% crown closure).

The terrain of our study area consists of a series of ridges and canyons. The spine of the Tehachapi Mountains is oriented southwest to northeast, and five major ridges extend perpendicularly from it to the northwest. The

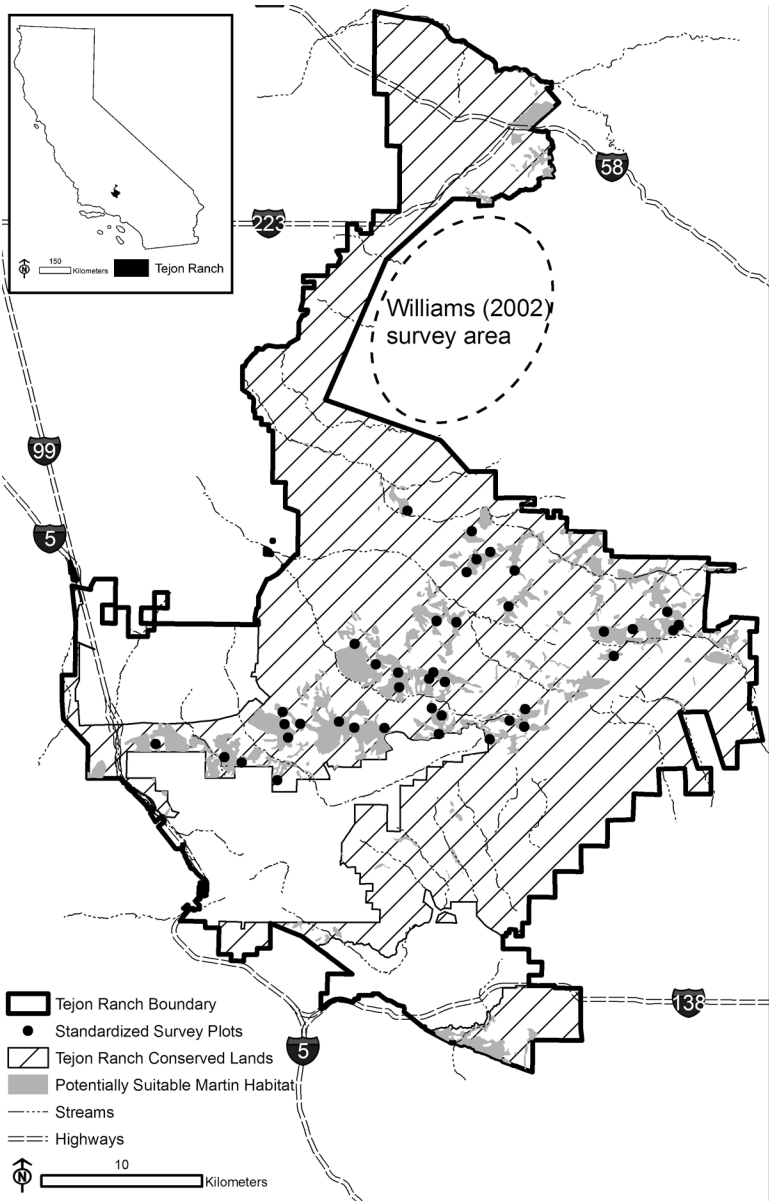

Figure 1. Map of Tejon Ranch showing the conserved lands, potentially suitable Purple Martin habitat, locations of standardized survey plots, and the area surveyed by Williams (2002).

ridge tops are broad and flat, but the flanks are often steep, dropping by as much as 2000 m into adjacent canyons. Many minor ridges extend from the flanks of the major ridges.

METHODS

We chose 29 June to 1 July as the survey period, as it was the period of predicted peak food delivery to Purple Martin nestlings in the Tehachapi Mountains (Williams 2002), facilitating our detection of Purple Martins. Eighteen surveyors divided into four to five teams. Survey participants consisted of Tejon Ranch Conservancy and Audubon California staff and volunteers affiliated with Western Field Ornithologists and Tejon Ranch Conservancy. Participants' experience with field surveys of birds varied, but each team included at least one member with extensive experience. Temperatures during the surveys ranged from 18 to 32 °C, skies were clear, and breezes were light.

We used two survey approaches, standardized surveys of randomly selected plots and nonstandardized surveys. Our standardized surveys took place within oak and mixed oak–conifer habitats potentially suitable for Purple Martin nesting on the basis of Williams' (2002) findings that martins nest in large Valley Oaks and, rarely, Blue Oaks in open woodlands or savannas. However, we did not constrain the habitat we surveyed by dominant tree species. Thus we considered habitat potentially suitable for Purple Martin nesting to be oak and conifer woodlands with canopy closure ≤40% and average tree size ≥0.3 m diameter at breast height (dbh) regardless of dominant species (Figure 1). We used 1980 digital forest-cover data (updated in 2000) in a geographic information system (GIS) to identify potentially suitable habitat. We selected 40 random points within areas of potentially suitable habitat, further constraining them to within 200 m of roads within the heart of Tejon Ranch (Figure 1). Each random point served as the center of a circular plot, radius 100 m, for standardized surveys.

In standardized surveys, a three- or four-person team surveyed each 3-ha plot once for 30 minutes between 07:30 and 13:00, counting all Purple Martins both inside and outside of the plot and all European Starlings and other cavity-nesting species inside the plot. We considered Purple Martin nesting confirmed when a martin entered a cavity or fed a fledgling outside of a cavity. For nest trees within the plots we recorded the tree's species, dbh, position on the slope (upper, middle, or lower third), and the slope's aspect. We also noted the orientation of the nest cavity's entrance and estimated canopy cover within 20 m of the nest tree. We tested the distributions of slope aspect and cavity orientation for deviation from uniformity with chi-squared goodness-of-fit tests (Sokal and Rohlf 1973).

Each day, after completing the standardized surveys, we surveyed other habitat potentially suitable for the Purple Martin on a less structured basis. These nonstandardized surveys generally covered the area around apparently suitable habitat sampled in the standardized surveys (Figure 1). However, nonstandardized surveys took place primarily along major ridges with ranch roads, and many minor ridges were not surveyed because of inaccessibility and lack of time. We did not survey patches of potentially suitable habitat

at the north and south ends of Tejon Ranch. Teams walked or drove slowly on roads through suitable areas, stopping periodically to listen for Purple Martin vocalizations and look for flying or perched individuals. Observers counted any observed Purple Martins and attempted to follow them to locate nest trees. At nest sites observers recorded the tree's characteristics as previously described.

RESULTS AND DISCUSSION

Nest-Site Characteristics

We detected Purple Martins at nine of 40 plots during standardized surveys but confirmed nesting at only four of these plots. Other observations at these plots were of individuals flying over or near the plots. In our descriptions of the nests' characteristics below we combine data for Purple Martin nests from the standardized and nonstandardized surveys.

In total, we located 23 Purple Martin nests in 22 trees (Figure 2), with 4 nests found during standardized surveys and 19 found during nonstandardized surveys. Nineteen (86%) of nest trees were on prominent northwest-trending ridges in an apparently aggregated distribution (Figure 2). Three other nest trees were on spurs of these major ridges or other minor ridges. While major ridges do tend to support abundant suitable Purple Martin nesting habitat, as we discuss further below, the apparent aggregation of nests on major ridges may reflect sampling bias. Nest trees were generally found along roads on major ridges (Figure 2), which are typically more accessible than minor ridges. We suspect that areas along roads on major ridges received more nonstandardized survey effort than minor ridges and areas not near roads.

All nests were in Valley Oaks. Most trees were large (Table 1), with half over 100 cm dbh and only six under 75 cm dbh. All nest trees were on the upper third of a slope in open stands, at an average elevation of 1321 m (range 965–1679 m). Our results are consistent with those of Williams (2002), who also found Purple Martins in the Tehachapi Mountains nesting in large Valley Oaks in open stands near the tops of ridges. The dbh and slope

Table 1 Characteristics of Trees in which Purple Martins Nest on Tejon Ranch.

Nest-site Characteristics	Value
Number of nest trees	22 (one tree had 2 nests)
Species	100% Valley Oak
Elevation (mean ± SE)	1321 ± 111 m
Diameter at breast height (mean ± SE)	104 ± 16 cm
Slope position	100% on upper third
Canopy cover within 20 m of nest tree (mean ± SE)	23 ± 6%
Slope aspect at nest tree[a] (mean ± SE)	210 ± 40°
Nest-cavity orientation[a] (mean ± SE)	161 ± 49°

[a]Direction in rotation clockwise from true north.

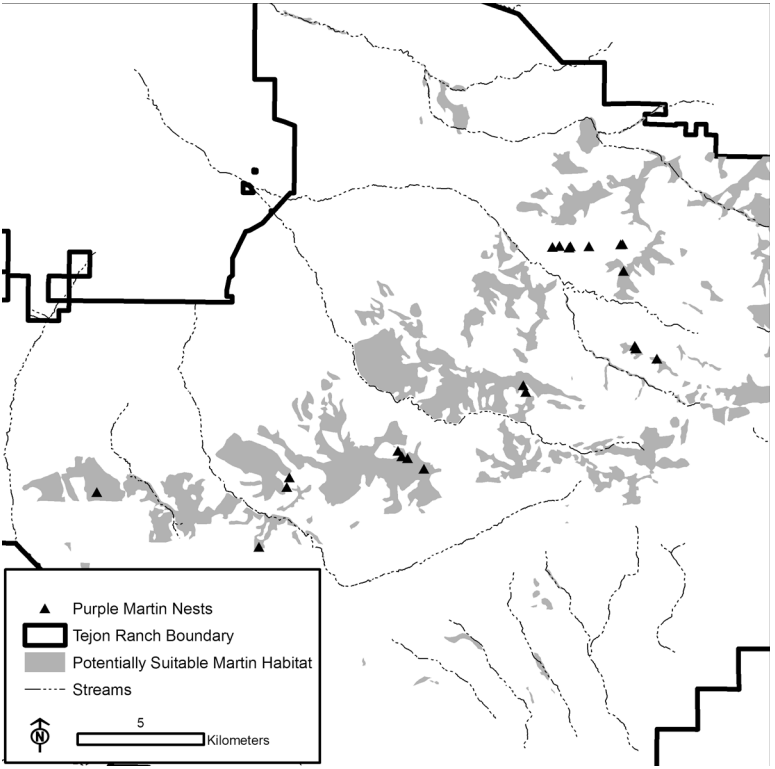

Figure 2. Locations of Purple Martin nests on Tejon Ranch in relation to habitat identified as potentially suitable by GIS.

position of nest trees we recorded are nearly identical to those reported by Williams (2002). In our survey, estimated tree cover around nest trees was 23% (Table 1). Williams (2002) estimated tree cover at a coarser scale, but it averaged in the range of 25–50%.

The aspects of slopes with nest trees were mainly between the southwest and northwest, and the orientation of nest cavities was to the northwest and southeast (Figure 3), although neither slope aspect ($P > 0.25$) nor cavity orientation ($P > 0.10$) of nest trees was statistically different from a uniform distribution. Because the ridges on Tejon Ranch trend northwest, southwest- to northwest-oriented slopes have the greatest solar exposures, resulting in more open canopy cover. Cavity openings facing east could aid in regulating temperatures in the nest cavity.

Although statistical comparisons are not possible with our data, we do not believe that our initial assumptions regarding potentially suitable nesting habitat biased our characterization of Purple Martin nest trees. Occupied Purple Martin nesting habitat appears to be a subset of the habitat we as-

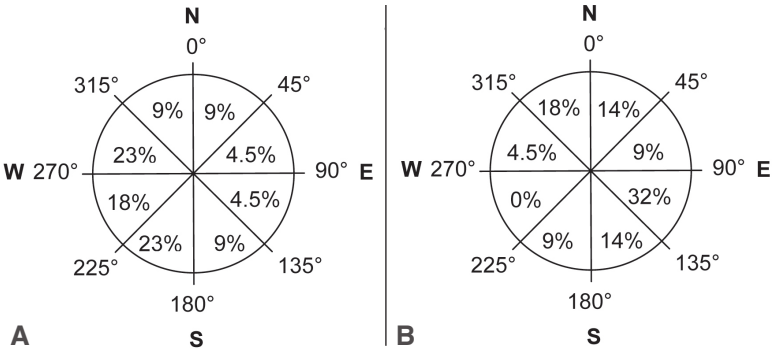

Figure 3. (A) Percent distribution of aspects (degrees clockwise from true north) of slopes supporting Purple Martin nest trees (n = 22) on Tejon Ranch. (B) Percent distribution of the orientation (degrees clockwise from true north) of nest cavities (n = 23) on Tejon Ranch.

sumed was potentially suitable for nesting. For example, martins appear to nest only in large Valley Oaks on the upper portions of slopes, but the habitat we searched included other oak species, a wider range of slope positions, and trees of smaller sizes. In some cases the resolution of the GIS data on forest cover we used to identify potentially suitable nesting habitat was too coarse to accurately characterize the stand of trees in which the martins were nesting. In addition, we used the habitat identified as suitable by GIS only to randomly select locations for standardized surveys. Survey teams were not constrained to GIS-identifed habitat during nonstandardized surveys, and we found Purple Martin nests outside of areas mapped as potentially suitable habitat (Figure 2).

European Starlings and Other Cavity Nesters

The densities of the 18 cavity-nesting species detected during standardized surveys are listed in Table 2. The cavity-nesting guild included five cavity-excavating woodpeckers, with the Acorn Woodpecker (*Melanerpes formicivorus*) the most frequent and abundant species in our plots. Williams (2002) also found the Acorn Woodpecker the most abundant woodpecker and speculated that this species is mainly responsible for creating cavities of a size sufficient for the Purple Martin.

We observed European Starlings in 18 of the 40 plots at an average abundance of 0.71 ± 0.26 individuals/ha. Starlings, however, were distributed among the plots patchily, as indicted by a high coefficient of dispersion or variance-to-mean ratio (Sokal and Rohlf 1973) of 3.65. The highest European Starling abundance on a plot was 8.7 individuals/ha.

Competition with the European Starling is considered a major threat to the Purple Martin in California (Airola and Williams 2008). Although the result of the comparison is not statistically significant, in our standardized surveys we found European Starling abundance in the vicinity of Purple Martin nests to be low. In the four standardized survey plots where Purple

Table 2 Cavity-Nesting Birds Observed during Standardized Surveys of 40 Plots in Tejon Ranch

Common name	Scientific name	Frequency of occurrence	Average abundance (no./ha ± SE)
Acorn Woodpecker	*Melanerpes formicivorus*	80%	2.11 ± 0.55
Violet-green Swallow	*Tachycineta thalassina*	75%	1.17 ± 0.22
Ash-throated Flycatcher	*Myiarchus cinerascens*	70%	0.52 ± 0.08
Western Bluebird	*Sialia mexicana*	68%	0.83 ± 0.13
White-breasted Nuthatch	*Sitta carolinensis*	55%	0.48 ± 0.19
Oak Titmouse	*Baeolophus inornatus*	50%	0.62 ± 0.18
House Wren	*Troglodytes aedon*	45%	0.48 ± 0.12
European Starling	*Sturnus vulgaris*	45%	0.71 ± 0.26
American Kestrel	*Falco sparverius*	25%	0.15 ± 0.05
Purple Martin	*Progne subis*	22%	0.25 ± 0.09
Northern Flicker	*Colaptes auratus*	18%	0.08 ± 0.03
Nuttall's Woodpecker	*Picoides nuttallii*	15%	0.07 ± 0.03
Hairy Woodpecker	*Picoides villosus*	8%	0.04 ± 0.02
Tree Swallow	*Tachycineta bicolor*	8%	0.03 ± 0.02
Mountain Chickadee	*Poecile gambeli*	5%	0.03 ± 0.02
Red-breasted Nuthatch	*Sitta canadensis*	3%	0.05 ± 0.05
Downy Woodpecker	*Picoides pubescens*	3%	0.01 ± 0.01

Martins nested, European Starling abundance was low, varying from 0 to 1 individual/ha. Of the 36 standardized survey plots located within 2 km of any Purple Martin nest tree, no European Starlings were detected in 22 plots (61%) and only three plots (8%) had >1 starling/ha. The three standardized survey plots where European Starling abundances were >2 individuals/ha were more than 2 km from any Purple Martin nest tree.

Conservation Implications

From our results and those of Williams (2002), the Tehachapi Mountains appear to be an important area for breeding of the Purple Martin in California. We documented 23 pairs of Purple Martins, and surveys of portions of Tejon Ranch outside of our study area revealed 6 additional pairs (Dudek 2009). We know of anecdotal reports of two or three additional pairs on or in the vicinity of Tejon Ranch (J. Grantham, D. Clendenen pers. comm.). Thus the southern Tehachapi Mountains support at least 31 known pairs of Purple Martins. If the current abundance of Purple Martins in the northern Tehachapis is consistent with Williams' (2002) report of 57 nests, then the Tehachapi Mountains as a whole support a minimum of 88 breeding pairs of Purple Martins.

Although suitable habitat is difficult to quantify, we estimate approximately half of that habitat in the Tehachapis remains unsurveyed for the Purple Martin. Therefore, the number of breeding pairs could be more than twice the 88 known pairs, consistent with Williams' (1998) estimate of 100–200 pairs in this mountain range. Airola and Williams (2008) estimated the entire California population at 900–1350 pairs. The Western Purple Martin Work-

ing Group has established a California population target of >2000 pairs (*fide* D. Airola). Thus the Purple Martin population in the Tehachapi Mountains likely represents 13–20% of the state's estimated current breeding population and 8% of the breeding pairs thought necessary to secure this species in California. The Tehachapi Range is also one of the few areas in the U.S. where Purple Martins nest in natural cavities in oak woodlands. To maintain potentially important genetic and behavioral characteristics of western Purple Martins, the Western Purple Martin Group set a target that 15% of the entire western Purple Martin population, including 75% of the breeding pairs in California, nest in natural cavities (*fide* D. Airola). Additional studies are needed for the distribution, population status, and ecology of the Purple Martin in the Tehachapi region to be better understood.

In much of the Purple Martin's breeding habitat at Tejon Ranch the European Starling appears to be in low abundance. However, a number of residential and commercial development projects have been proposed for the Tehachapi region, development that may have an adverse effect on the Purple Martin by creating favorable conditions for European Starlings around structures and human-modified habitats. Although additional research is needed to clarify the nature and extent of competition between the European Starling and Purple Martin in the Tehachapis, plans for development should consider the potential effects, both direct and indirect, on the Purple Martin in this region and develop measures for monitoring and managing the European Starling. Conservation of the Purple Martin population in the Tehachapi Mountains, including land use and management to prevent increases in the European Starling population, represents an important contribution to the goals for this species' conservation in western North America.

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LITERATURE CITED

Airola, D. A., and Kopp, D. 2009. Recent Purple Martin declines in the Sacramento region of California: Recovery implications. W. Birds 40:254–259

Airola, D., and Williams, B. D. C. 2008. Purple Martin (*Progne subis*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 293–299. Studies of Western Birds 1. W. Field Ornithol., Camarillo, and Calif. Dept. Fish and Game, Sacramento.

Dudek. 2009. Tejon Mountain Village biological resources technical report. Prepared for Tejon Mountain Village, LLC; www.co.kern.ca.us/planning/pdfs/eirs/TMV/TejonMountainVillageVolume9.pdf

Grinnell, J. 1905. Old Fort Tejon. Condor 7:9–13.

Kostka, S., and McAllister, K. 2005. Purple Martin, in Birds of Washington: Status and Distribution (T. Wahl, B. Tweit, S. Mlodinow, eds.), pp. 269–270. Ore. State Univ. Press, Corvallis.
Miller, A. H. 1951. An analysis of the distribution of the birds of California. Univ. Calif. Publ. Zool. 50:531–644.
Sokal, R. R., and Rohlf, F. J. 1973. Introduction to Biostatistics. W. H. Freeman, San Francisco.
Williams, B. D. 1998. Distribution, habitat associations, and conservation of Purple Martins breeding in California. M.S. thesis, Calif. State Univ., Sacramento.
Williams, B. D. C. 2002. Purple Martins in oak woodlands. USDA Forest Service Gen. Tech. Rep. PSW-GTR-184.
Zwinger, A. H. 1986. John Xántus: The Fort Tejon Letters. Univ. of Ariz. Press, Tucson.

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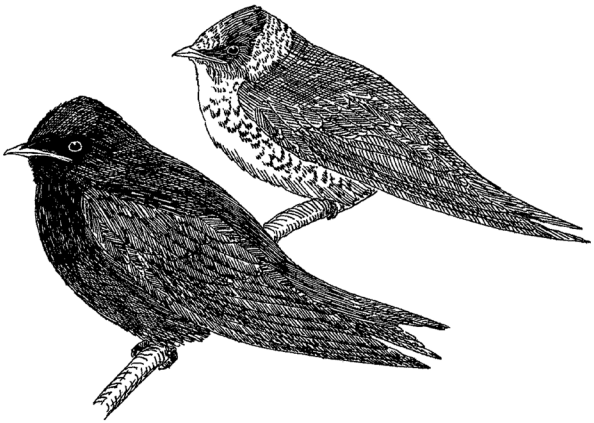

Purple Martins

Sketch by George C. West