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RECENT PURPLE MARTIN DECLINES IN THE SACRAMENTO REGION OF CALIFORNIA: RECOVERY IMPLICATIONS

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ABSTRACT: We monitored the Purple Martins (*Progne subis*) breeding in the Sacramento region, California, in 2008 and 2009, following similar monitoring from 2002 to 2007. This bridge-nesting population is the last remnant of the formerly widespread Central Valley population. All 11 colonies occupied in 2007 remained active in 2008, but the number of occupied colonies declined to 9 in 2009. From 2007 to 2009 the number of breeding pairs declined by 34%, from 106 to 70. Since 2004, the population has declined by 60% (103 pairs), and the annual rate of decline has increased. Probability calculations suggest the decline has been caused by factors other than chance fluctuation. If the decline continues at its current rate, the population will be extirpated within 22 years. Causes of the decline are unknown, but our previous studies have implicated mortality during the breeding season from vehicle collisions. Sacramento-area populations also are threatened by disturbance from a variety of construction projects and land-use changes that may affect habitat suitability. Recent losses in Sacramento represent a 6–11% decline in California's estimated Purple Martin population. Increased effort is needed to stabilize the Sacramento population, which would serve as the likely source for any future recovery within the Central Valley.

The Purple Martin (*Progne subis*) is recognized by the California Department of Fish and Game as species of special concern because of reductions in its geographic range and numbers (Airola and Williams 2008). The martin population in the Sacramento area (mostly within the city of Sacramento, as well as limited areas in adjacent Placer and Yolo counties) is a remnant of a population once more widespread in California's Central Valley. This population apparently has survived competition from the European Starling (*Sturnus vulgaris*) by nesting in overpasses and elevated freeways (collectively, bridges), which are entered through "weep holes" on the undersides of the structures (Airola and Grantham 2003). The Sacramento population has, until recently, constituted approximately 9–21% of the total estimated nesting in California (Airola and Williams 2008).

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We monitored the Purple Martins breeding around Sacramento from 2002 to 2007 (Airola et al. 2008) after conducting similar surveys in the early 1990s (Airola and Grantham 2003). Here, we report the population's status in 2008 and 2009 and implications of recent trends for conservation of the species.

STUDY AREA AND METHODS

We studied Purple Martins at bridges in the Sacramento region (Sacramento, Yolo, and western Placer counties) previously identified as occupied or suitable for use by the species. Locations of colonies and other suitable sites, and the criteria used to define them, were described by Airola and Grantham (2003), Leeman et al. (2003), and Kopp and Airola (2007).

Survey methods included mapping of holes in which martins nested, re-recording diagnostic nesting behaviors [carrying food to nests, removal of fecal sacs, juveniles begging, or seeing nestlings in holes (Airola and Grantham 2003, Leeman et al. 2003)], and video monitoring of a sample of accessible nest sites (see Airola et al. 2008 for methods). These methods provide a consistent and repeatable basis for estimating numbers.

We confirmed breeding by 93% and 96% of pairs in 2008 and 2009, respectively, through observation of diagnostic nesting behaviors and video monitoring at 35% (2008) and 38% (2009) of nest sites. Remaining nests were inferred on the basis of pairs entering holes frequently over the nesting season (see Airola and Grantham 2003 and Airola et al. 2008).

RESULTS

In 2008, Purple Martins bred in the same 11 sites they used in 2007 (Table 1). The newest site, at Highway 65 and Taylor Road in Placer County (Kopp and Airola 2007), was reoccupied by a single pair of Purple Martins that contained a male in typical dark after-second-year plumage (Pyle 1997), suggesting the return of the male that bred there in second-year plumage in 2007. As in 2007, the formerly used Marconi, Airbase, and Pole Line sites remained unoccupied again in 2008 and 2009. In 2009, martins bred at only nine colonies (Table 1), the first time since extensive surveys of all suitable sites were initiated in 2003 that the number of colonies has dropped below 11. Second-year birds were seen at both the Marconi and Pole Line colonies but did not nest. Fifteen other sites previously identified as suitable (Leeman et al. 2003, Kopp and Airola 2007) but never known to be occupied also were surveyed in 2008 and 2009 and did not support nesting martins.

The number of pairs of Purple Martins nesting around Sacramento declined during both 2008 and 2009. The 2009 total of 70 pairs represents a decline by 34% from the number in 2007, by 60% from the peak in 2004 (Table 1), and the fifth consecutive year of decline. At eight colonies, numbers in 2009 decreased from those in 2007, while they remained the same at one colony and increased at two. No obvious causes for the changes were evident. As in previous years, colonies in the more urbanized downtown areas (I St., 20th St., Broadway, 35th St., S St.) declined from 2007 to 2009

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Table 1 Number of Breeding Pairs of the Purple Martin around Sacramento, California, 2002–2008

Colony	2002	2003	2004	2005	2006	2007	2008	2009
I Street	37	29	35	32	17	11	6	5
20 th Street	14	21	23	23	16	15	6	5
Sutterville	4	6	8	5	6	6	5	6
Broadway	8	7	7	7	5	1	1	0
S Street	14	14	16	14	18	9	7	6
35 th Street	29	19	15	14	6	3	3	1
Redding Rd.	0	3	12	10	14	14	15	17
El Camino	ns ^a	15	23	21	21	20	11	5
Marconi	ns	1	4	3	0	0	0	0
Roseville Rd.	29	39	27	24	24	17	17	13
Arden	ns	0	3	6	13	9	11	12
Airbase	ns	0	0	1	1	0	0	0
Pole Line	ns	2	0	0	0	0	0	0
Hwy. 65/Taylor	ns	ns	ns	ns	ns	1	1	0
Total	135	156	173	160	141	106	83	70

^ans, not surveyed.

at a higher rate (59%) than did more outlying colonies (21%), although this difference is only marginally significant statistically ($\chi^2_1 = 3.05$, $P = 0.08$). Since 2004, when the size of the nesting population peaked, downtown colonies have declined by the significantly greater rate of 82% (from 96 to 17 pairs), while outlying colonies have declined by 31% (77 to 53 pairs; $\chi^2_1 = 79.7$, $P < 0.0001$).

DISCUSSION

The 2008 and 2009 declines in the number of Purple Martins nesting in Sacramento represent the fifth consecutive year of decline following two years of increases (Table 1). The 2008 and 2009 populations are lower than any recorded previously in 10 surveys since 1992 (Airola and Grantham 2003, Airola et al. 2008), despite surveys since 2003 being more comprehensive (Table 1).

How likely is it that recent declines represent a trend or a population fluctuation? We address this question in several ways. First, the annual rates of population decline appear to be accelerating, from 8% in 2004 and 12% in 2005 to 16–25% from 2007 through 2009. Second, we calculated the probability that by chance alone the population could have declined five years in a row over our eight years of monitoring. If the probability of an increase or decline in any one year is 0.5, the probability of five consecutive annual declines (one of six possible outcomes over seven years) is $P = 6(0.5)^7 = 0.047$, a figure strongly suggesting that a cause other than chance is responsible.

Notwithstanding the relatively large declines in 2008 and 2009, most recent colonies remained occupied. Several colonies that supported a single pair in 2008 (Broadway and Highway 65/Taylor Rd) were abandoned in 2009, and the 35th St. colony declined to a single pair. Maximizing the

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number of colonies may be important for conservation because the Purple Martin's colonial habits may discourage reoccupation of sites once they are abandoned, especially because declining populations likely reduce pressure on new breeders to disperse to unoccupied sites. The observation in 2009 of nonbreeding birds at two sites previously abandoned (Marconi and Pole Line), however, suggests the possibility of recolonization of these sites, and perhaps others, when the population is healthier.

A reduction in the number of active colony sites presumably increases the risk that a future disturbance or habitat changes at an occupied site could affect the population disproportionately. Such disturbance is a substantial threat, as 60% of the 2009 population is breeding at sites that have been recently affected by, or are proposed for, construction projects that may disturb the bridges, the lands below them, or alter the habitat immediately adjacent to sites (updated from Airola et al. 2008).

Protecting habitat at current colonies, however, also requires considerable understanding of local patterns of habitat use such as flight paths to nests, sources of nest material, and perch sites. Also, appropriate protection from construction disturbance requires recognition that Purple Martins tolerate considerable activity as long as nest sites remain secure (Airola et al. 2009). Excluding Purple Martins from their nesting areas during construction (as is typically done for other bridge-nesting swallows) reduced the subsequent nesting population at one Sacramento colony (Airola and Grantham 2003, Airola et al. 2004). Because such exclusion and displacement also likely reduces reproductive success and risks long-term abandonment of colonies (Airola and Grantham 2003) it should be used cautiously.

CONSERVATION IMPLICATIONS

The Purple Martin's nesting population in the Sacramento area has declined despite considerable efforts to protect and enhance it, including removing feral cats where they preyed on Purple Martins collecting nest material, reducing collision mortality with trains, reducing nestlings' falling out of nests, rehabilitating fallen nestlings, removing encroaching vegetation that blocked access to nest sites, and protecting colony sites from construction and from land uses beneath and adjacent to sites (Airola and Grantham 2003, Airola et al. 2008). Causes of the decline remain uncertain. Previous studies have indicated that the Sacramento bridge-nesting population is not limited by lack of suitable nesting habitat, infection by West Nile virus or other diseases, high predation rates, or competition with the European Starling (Airola and Grantham 2003, Leaman et al. 2002, Airola and Kopp 2007, Airola et al. 2008).

Airola et al. (2008) suggested that an increase in traffic and other disturbance associated with urban redevelopment may be increasing mortality from vehicle collisions during the nesting season. The higher rate of decline since 2004 at downtown colonies, where traffic volumes are higher, is consistent with this hypothesis. Notwithstanding evidence suggesting anthropogenic causes of decline, it remains possible that declines are related to short-term variation in weather, which we have not examined rigorously, or other unknown causes.

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More detailed evaluation of the timing of mortality (breeding season versus migratory and wintering period) is underway, which may help to illuminate critical causes of mortality. Additional evaluation of reproduction and mortality rates also is needed to clarify the role of these factors in determining the sizes of breeding populations.

Regardless of causes of declines, if the 16.5% average annual population decline from 2004 to 2009 were to continue, the Sacramento Purple Martin population would be eliminated within 22 years. However, the martin's colonial nature suggests benefits from group living (i.e., for increased fitness from extra-pair copulation and predator detection; Stutchbury 1991). Therefore, it is possible that as martin numbers at individual colonies decrease, the rate of population decline may accelerate further. The abandonment of two small colonies in 2009 may illustrate this process.

The recent decline in Sacramento's Purple Martin population is also important in a larger context, because of the small size and declining trend of the population statewide (Airola and Williams 2008). The recent decline by 103 pairs in Sacramento represents a loss of 6 to 11% of California's estimated population of 900–1850 pairs, which was based primarily on surveys conducted in the 1990s but updated to reflect the 2004 census for Sacramento (Airola and Williams 2008). Unfortunately, few other martin populations in California have been monitored systematically since Williams' (1998) surveys in the early 1990s, so it is unknown whether the recent declines in Sacramento are isolated or part of a broader trend. The population at Shasta Lake, the only other site of relatively consistent long-term monitoring in northern California, appears to be stable (Lindstrand 2008). A pilot survey initiated in 2009 by Airola and volunteers at a sample of northern California sites occupied in the 1990s may provide a broader indication of the martin's status in this region.

The continued decline in the number of Purple Martins breeding in Sacramento argues for higher conservation concern for this remnant population. Therefore, additional effort is warranted to continue monitoring the population to reveal the causes of recent declines, to minimize effects of construction projects, land-use changes, and vehicular traffic at martin colonies, and to establish a population nesting in boxes (Kostka et al. 2008, Elwood et al. 2009) to bolster the existing population and reduce risk of extirpation. Loss of the Sacramento population would eliminate the primary source of potential colonists for new bridges or nest boxes and so could preclude the possibility of population recovery in the Central Valley. The results of monitoring in 2008 and 2009 further support previous suggestions (Airola et al. 2008) that protection of the bridge-nesting martin population in Sacramento is critical as a strategy for recovery.

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