

PURPLE MARTIN POPULATION STATUS, NESTING HABITAT CHARACTERISTICS, AND MANAGEMENT IN SACRAMENTO, CALIFORNIA

DANIEL A. AIROLA, Jones & Stokes, 2600 V Street, Sacramento, California 95818

JESSE GRANTHAM, National Audubon Society, 205 N. Carrizo Street, Corpus Christi, Texas 78401 (current address: U. S. Fish and Wildlife Service, Hopper Mountain National Wildlife Refuge Complex, 2493 Portola Road, Suite A, Ventura, California 93003)

ABSTRACT: The Purple Martin (*Progne subis*) has been eliminated from most of California's Central Valley. The last known population nests in elevated roadways ("bridges") in the city of Sacramento. We reviewed bird records (1949–1990), conducted surveys to assess population size and trend (1991–2002), and evaluated management actions to protect and increase populations. Martins ceased nesting in buildings in Sacramento in the 1960s and 1970s as the European Starling (*Sturnus vulgaris*) population exploded, but adoption of vertical weep holes for nesting beneath bridges in the 1960s has allowed martins to persist. The known Sacramento population increased from four to seven colonies and from approximately 105 to 135 nesting pairs from 1992 to 2002. Martin colonies are located in longer (>85 m) bridge sections that provide at least 6 m of unobstructed airspace beneath the colonies. Management has included a pilot project to insert wire "nest guards" in weep holes to increase survival of young and protecting nesting colonies during construction activities near nests. Initial results indicate that nest guards reduce mortality of young falling from nests and do not result in increased competition for nest sites by starlings and other species. Exclusion of martins from nesting at a large colony to prevent disturbance from a construction project reduced nesting use of the site; such exclusion is not considered necessary to protect nesting birds. Martin recovery may require substantial management, including protecting and enhancing existing colonies, encouraging colonization of other elevated road sites, establishing martin use of artificial nest structures in unoccupied regions, and enlisting public adoption of management responsibility.

The Purple Martin (*Progne subis*) was once considered "fairly common" in California (Grinnell and Miller 1944) but recently has been considered rare to very uncommon in the state (Garrett and Dunn 1981, Zeiner et al. 1990, Williams 1998). The state of California identified the martin as a species of special concern because of a well-documented and drastic population decline and substantial reduction in the species' geographic range (Remsen 1978). A review of the status of the martin in California also confirmed that Sacramento remains the only location in the Central Valley where the species is known to breed (Williams 1998).

The major suggested cause of martin decline in California is competition for nest holes with the nonnative European Starling (*Sturnus vulgaris*) (Remsen 1978, Garrett and Dunn 1981, Williams 1998, 2002). Detrimental effects of starling and House Sparrow (*Passer domesticus*) competition are well documented elsewhere in the U.S. (Brown 1981, 1997) but not specifically in California. Williams (1998) has also suggested that loss of riparian habitat and snags that represented suitable nesting habitat may have

contributed to martin decline in California. Pesticide effects have not been documented but cannot be dismissed.

In the eastern U.S., Purple Martins have relied on birdhouses and gourds as nesting sites for many years (Jackson and Tate 1974, Brown 1997). In the west, Purple Martins have only recently made substantial use of nest boxes in Oregon, Washington, and British Columbia (Copley et al. 1999, Fouts 1996, Horvath 1999). In California, martins formerly nested commonly in buildings but have seldom used nest boxes (Grinnell and Miller 1944, Garrett and Dunn 1981, Williams 1998). In the 1930s and 1940s, use of buildings in cities and towns in California was thought to have increased the state's martin population and range (Willett 1933, Grinnell and Miller 1944). Today, however, no urban areas except Sacramento are known to support nesting martins (Williams 1998).

As summarized by Williams (1998), Purple Martins were reported nesting in trees in Sacramento as early as 1853 (Baird 1858) and were documented nesting in buildings as early as 1924 (Bryant 1924). Nesting in buildings occurred mainly in holes formed by hemicylindrical roof tiles (i.e., Spanish tiles). No recent nests have been reported in buildings in Sacramento (B. and H. Kimball pers. comm.); all recent nesting has occurred in weep holes beneath bridges (including elevated freeways).

We initiated this study in 1991 and 1992 to evaluate the recent historical and current population status and nest site characteristics of the Purple Martin in Sacramento and to assess the effectiveness of management actions for the species. Grantham continued monitoring through 1997 at one site (see Study Area), and Airola reinitiated monitoring in 2002 to assess the population trend. This assessment also incorporates information collected at Sacramento colonies by Williams (1998).

The study's objectives were to:

- identify recent historical and current martin colonies in the Sacramento area.
- evaluate changes in local distribution and habitat use at martin colony locations.
- estimate current populations and recent trends at colonies.
- identify factors that may influence selection of colony sites.
- evaluate effectiveness of recent management actions to protect and enhance martin nesting habitat.
- identify threats to colonies and additional research and management needs.

STUDY AREA

We surveyed for Purple Martins at bridges and buildings in the Sacramento area where they had previously been observed nesting, as well as at other bridges with similar characteristics. All sites used by martins were in bridges built of steel and concrete box girders (Tonias 1995). All these bridges span urban areas and railroad tracks; none crosses water. The bridges support an enclosed chamber beneath the road surface. Weep holes on the underside of the chamber relieve air pressure during heating and

cooling and drain condensation, but they do not drain water from the road surface.

The downtown area contains the greatest number of bridges in the region. We surveyed suitable bridge sections to locate colonies in 1991, 1992, and 2002. Colonies were defined as occupied sites separated by areas of unsuitable or unoccupied habitat that exceed the typical distances between nests within occupied sites.

We studied four occupied colony sites in detail in 1991 and 1992:

- I Street—Interstate 5 at I Street in Old Sacramento.
 - 20th Street—U.S. Highway 50 between 19th and 21st streets.
 - Broadway—the junction of State Route 99 and U.S. 50, above and adjacent to Broadway.
 - 35th Street—U.S. 50 between 34th Street and Stockton Boulevard.
- Grantham continued monitoring the 35th Street colony through 1997. We studied three additional occupied colonies in 2002:
- Sutterville—Sutterville Road overpass of the Union Pacific Railroad (UPRR) yard.
 - S Street—Capital City Freeway (Business Route 80) at S Street.
 - Roseville Road—I-80 and the adjacent light rail parking-access ramp above Roseville Road and the UPRR tracks.

METHODS

Review of Recent Historical Records

Because available information on the early historical status of the Purple Martin is limited and has been summarized (Williams 1998), we confined the status review to the period since the mid-1900s, for which a substantial number of records were available. We reviewed approximately 970 martin records (1949–1990) from the Sacramento area that Betty and Harold Kimball compiled from their personal field notes, as well as records of other members of the Sacramento Audubon Society (unpubl. data). Other local records from California Department of Fish and Game files were provided by J. Estep and R. Schlorff (pers. comm.).

Many recent historical records noted locations of birds near known nesting colonies but did not confirm breeding activity. We considered breeding at a site to be possible if records noted that birds were present during the peak breeding season (mid-April through July) at a specific building or site, probable if birds were reported entering holes or carrying nesting material, and confirmed if adults were observed carrying food to a nest hole or feeding dependent young, if juveniles were observed within holes, or if recently fledged juveniles were reported near a known site.

We used 1965–1990 records only to document trends in colony locations and nesting habitats. We could not determine abundance and detailed occupation patterns because of limited information on nesting activity. Also, the reported incidental counts of martins are not reliable indicators of colony size (see Results). The first year of site occupation was especially difficult to establish because all potential sites were not surveyed systematically. Site

abandonment dates are more reliable because once the sites were known, observers tended to visit them annually (B. and H. Kimball pers. comm.).

Surveys for Breeding Colonies

We surveyed previously reported martin colonies in 1991, 1992, and 2002. We also surveyed many other sites in Sacramento that could be nesting habitat; these included longer sections of elevated freeway, overpasses with weep holes, and buildings with Spanish tile roofs. We surveyed 25 potential nesting areas from April to July by searching for flying and perched birds. We conducted most surveys before 11:00 or after 17:00 because birds tended to be more active during these periods, especially on hot days (Airoola unpubl. data).

Population Estimation at Colonies

Determining population sizes of nesting colonies in bridges is difficult because martins can be counted only as they enter or leave holes or when they are perched or foraging near the colonies. At any time, many birds in a colony cannot be counted because they are inside nest holes, foraging or perching away from colonies, or obstructed from observation by the overhead structure. Also, most chambers within bridges cannot be entered to observe nests. Accordingly, we used two primary approaches to evaluating population sizes: observation of nesting behaviors and hole use, and direct counts.

Evaluation of Nesting Behaviors and Hole Use. With the assistance of a group of trained volunteers, we estimated populations at colonies by observing nesting behavior and mapping bird use of individual weep holes throughout the nesting season. We developed and tested this method in 1991, but because effort and methods were inconsistent that year, we have not reported those results. We prepared maps of available weep holes for each colony site and assigned each hole a unique alphanumeric code. We visited each colony site repeatedly during the nesting season to count birds and map holes entered by martins. During the two years of most thorough surveys (1992 and 2002), we monitored each occupied colony for an average of 8 hours on an average of 13 days at 3- to 9-day intervals (Table 1). We documented more than 2000 individual hole entries by martins annually during 1992 and 2002.

We estimated numbers of nesting pairs on the basis of diagnostic nesting behavior and the frequency of hole use. Diagnostic behaviors that demonstrated nesting use of a weep hole by a pair included adults entering holes with food, adults carrying fecal sacs from holes, vocalizations of begging young, visible presence of young in nest holes, and presence of dead young beneath nest holes.

Diagnostic nesting behaviors were difficult to observe at some sites because of limited access and limited time to observe arrivals at and departures from holes (i.e., birds were often visible for only a few seconds). Accordingly, we also considered holes to be occupied by nesting pairs if adults made repeated visits to specific holes over the course of the nesting period. We considered holes entered two or more times on each of two or

Table 1 Survey Effort Assessing Purple Martin Breeding Populations in Sacramento during Two Years of Comprehensive Surveys

Colony	1992		2002	
	Days	Hours	Days	Hours
I Street	5	3.9	34	20.8
20th Street	17	5.3	12	6.7
Broadway	7	4.7	10	4.4
35th Street	20	15.0	13	12.0
Sutterville ^a	3	1.2	12	4.3
S Street ^a	3	1.3	10	5.0
Roseville Road ^b	0	0.0	4	6.1
Total		31.4		59.3

^aUnoccupied in 1992.

^bNot surveyed in 1992.

more days separated by more than one week during the nesting period to be occupied by a nesting pair. In general, the numbers of individual visits and days with visits recorded for most pairs considered to be nesting exceeded this minimum standard. In addition, we combined hole-use counts with less diagnostic behaviors (especially carrying nesting material) to indicate occupancy.

Estimation of populations by behavioral observation and hole mapping is affected by the amount of observation time. Levels of effort at three sites occupied in both 1992 and 2002 were comparable, but we spent substantially more time monitoring the I Street site in 2002 than in 1992 (Table 1). Low survey effort for the S Street and Sutterville sites in 2002 reflected the absence of the species from these sites that year. We have included population data collected by Williams (1998), who used methods generally consistent with ours.

Direct Counts. Because determining population sizes on the basis of nesting behaviors and hole use was so labor intensive, we evaluated the simpler method of directly counting numbers of individuals observed at colonies (direct counts). We evaluated the effectiveness of direct counting as a census technique or population index by comparing direct counts to numbers determined on the basis of behavioral observation and hole-use mapping. Direct counts were made during each visit by repeatedly counting the number of adults observed flying or perching near colonies or known to be in weep holes simultaneously, then recording the highest of these counts for each day. The proportion of the total population at each site observed during direct-count surveys was calculated by dividing the maximum number of birds observed during direct counts over the season by the number of nesting individuals determined to be at colonies on the basis of hole use and nesting behavior.

Habitat Characteristics at Nesting Colonies

Nesting sites and bridge sections not used for nesting were evaluated for a variety of characteristics, including

- length and width of the bridge section.
- height of holes from the ground or other flight obstructions.
- pedestrian activity, lighting, and other human uses (including construction activity).
- availability of nesting material and perch sites.
- relative levels of vehicular traffic beneath sites.
- distance to non-urban foraging areas.

Nestling Mortality

Discovery of dead nestlings below weep holes during population surveys prompted us to investigate the loss of nestlings from nest holes as a mortality source further. On the assumption that young more than 7 days old that were found beneath nest holes had fallen accidentally, we hypothesized the cause to be the lack of any physical barrier at the upper edge of the vertical nest hole. We systematically monitored mortality beneath nests at several colonies where vegetation or debris did not obscure our ability to locate fallen young. We conducted surveys for fallen nestlings every one to three days from mid-June to mid-July, the peak period of susceptibility, and left a sample of dead young in the field to assess losses due to scavenging by predators and pulverization by car tires. We determined ages of young from reference photographs (Rogillio 1992, Hill 1999).

Effectiveness of Nest Guards in Reducing Nestling and Fledgling Mortality

As a pilot project, Grantham devised wire nest guards and installed them in occupied and suitable weep holes at the 35th Street site from 1992 to 1996 (Figure 1). The guards, made of 0.5-inch hardware cloth (wire screen), were designed to provide an internal barrier (i.e., a "fence") to prevent young from falling from nests (see Kostka et al. 2003 for nest-guard design and installation). Effectiveness of nest guards in reducing nestling mortality was evaluated by comparing results of surveys for fallen young before and after installation (1992 and 2002).

Effects of Nest Guards on Roosting by Fledglings

Following fledging, Purple Martin young typically roost at night in the nest cavity for 1 to 12 days (Brown 1997). Because we observed recently fledged young experiencing difficulty reentering weep holes to roost in the evening (see Results), nest guards were also designed to provide a wire ladder to enhance the ability of recent fledglings to reenter holes to roost. We monitored the return of fledglings at the 35th Street site during the post-fledging period in 1992 and 1993 to assess their abilities to enter roost holes with and without nest guards.



Figure 1. Female Purple Martin with food perching at a wire "nest guard" inserted into a weep hole beneath an elevated freeway in Sacramento, California.

Photo by Sacramento Bee/Chris Crewell

Competitor Use of Weep Holes with Nest Guards

Weep holes appear to represent the only nesting substrates in the Central Valley where starlings have not been able to displace martins. Because of the concern that the insertion of nest guards could make nest holes more accessible to starlings and other potential competitors, Airola evaluated use by competitors of holes with and without nest guards at the 35th Street site in 2002. Potential effects of wire sleeves on competitive interactions were analyzed by evaluating patterns of use by the species (i.e., use of holes with and without nest guards and changes in holes used over time by martins and competitors).

Locations of Holes Used by Martins and Starlings within Nest Colonies

In 2002, Airola initiated a study of hole-use locations by martins and starlings at the 35th Street colony. He mapped hole use by starlings during martin surveys at this site. Hole locations were characterized by their position (i.e., outermost, next to outermost, or interior) relative to the edge of the bridge. To assess for selection (non-random use) of nesting locations by each species at this colony, the number of holes used in each position was compared against an expected value, based on the proportional availability of holes in each category. Differences were tested for significance by the chi-square goodness-of-fit test (Sokal and Rohlf 1995).

